NORRIS

& DICKINSON

TEXT BOOK

OF OBSTETRICS

FRONTISPIECE.

Mesial section showing the relation of the viscera in their normal positions (Dickinson).

(*For details see Fig. 22, p. 42.*)

AN AMERICAN TEXT-BOOK OF OBSTETRICS

FOR PRACTITIONERS AND STUDENTS

BY

JAMES C. CAMERON, M.D., EDWARD P. DAVIS, M.D.
ROBERT L. DICKINSON, M.D., CHARLES WARRINGTON
EARLE, M.D., JAMES H. ETHERIDGE, M.D., HENRY J.
GARRIGUES, M.D., BARTON COOKE HIRST, M.D.
CHARLES JEWETT, M.D., HOWARD A. KELLY, M.D.
RICHARD C. NORRIS, M.D., CHAUNCEY D. PALMER, M.D.
THEOPHILUS PARVIN, M.D., GEORGE A. PIERSOL, M.D.
EDWARD REYNOLDS, M.D., HENRY SCHWARZ, M.D.

RICHARD C. NORRIS, M.D., EDITOR.

ROBERT L. DICKINSON, M.D., ART EDITOR.

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PREFACE.

THE ADVANCES in the science and art of obstetrics have kept pace with the advances which have characterized all branches of medicine and surgery. Although our standard text-books of obstetrics have occasionally been *revised*, an entirely new text-book containing the writings of more than one individual has not appeared during the last decade. The AMERICAN TEXT-BOOK OF OBSTETRICS owes its existence to the fact that it seemed practicable to produce a work which should not only embody the teachings of several prominent American obstetricians, thus reflecting all recent progress made in the theory and practice of obstetrics, but should also be a standard teaching-work for students and a guide for practitioners; for this purpose the authors selected are those possessing experience as teachers of obstetrics in several of the leading medical schools and hospitals of America.

The especial design in preparing this volume was to make clear those departments of obstetrics that are at once so important and usually so obscure to the medical student. Therefore the obstetric emergencies, the mechanics of normal and abnormal labor, and the various manipulations required in obstetric surgery are all described in great detail, the text being elucidated with numerous illustrations and diagrams which will materially assist the student to grasp the complex problems of operative obstetrics. The diseases of the fetus and of the new-born infant are given separate sections of the volume, this subject being discussed more fully than is usual in obstetrical works in the English language. An effort has been made to render attractive the sections upon Anatomy and Embryology.

While the various authors were each assigned special themes for discussion, nevertheless an attempt has been made so to correlate the subject-matter as to preserve throughout the text a logical sequence not always found in composite publications. The writing of the subjects assigned to Dr. Charles Warrington Earle was only fairly begun when his untimely and widely-lamented death occurred. The Editors were gratified to secure for the revision and completion of Dr. Earle's manuscript one of his associates, Dr. M. J. Mergler. The table of Contents indicates the authorship of each section—a feature which doubtless will give satisfaction.

One of the just claims of this text-book to originality is that an attempt has been made to carry out systematically the following principles in its illustration: All figures to be drawn to scale; a uniform scale to be adopted, usually one-third or one-sixth life size; in sagittal sections the same half always to be shown for ease of comparison; full labelling to be made directly on the drawing, to which should be given as much artistic treatment as would be compatible with clearness and with teaching quality. The scale of the cuts in most previous text-books, and the choice of the sagittal section—right or left—have varied. In this book the left half of the section has preferably been chosen, because it is the one made familiar to practitioners by the treatment of patients in the latero-prone posture.

Each borrowed engraving has been credited to its source in all cases where it could be traced. When alterations have not been extensive these cuts are designated, respectively, as "redrawn from" or "modified from" the original. When such corrections and additions have been made as to constitute practically a new drawing, the origin of the cut is rarely indicated. Where there may seem to be strong resemblance to older work, without credit, it will be found that new photographs or sketches are the basis of the new illustration. The borrowed cuts have all been redrawn, excepting those reproduced from the old copper-plates of Hunter and Smellie—a standard of artistic excellence set for us by the most famous engravers of England. France, which has furnished our specialty with its stock-cuts for decades, gives the "American Text-Book" many suggestions through the work of Farabeuf and Varnier. To Germany obstetrics owes much gratitude for that accuracy in topographical anatomy which had its rise in the beautifully pictured sections of Braun, Schroeder, Waldeyer, and Zweifel; while we thank Scotland, through the atlases of Hart, Barbour, and Webster, for the knowledge of the structure of the pelvic floor.

Some of the finest pathological specimens illustrated in this text-book were photographed at the Army Medical Museum at Washington, D. C., through the painstaking courtesy of Dr. D. S. Lamb, while Dr. Farquhar Ferguson gave access to the New York Hospital Cabinet, and Professors Piersol and Hirst each brought forward some of their most striking preparations.

We are indebted to the staff of artists, Messrs. Max Colin, W. A. C. Pape, H. C. Lehmann, F. V. Baker, A. B. Doggett, F. Deck, W. H. Richardson, and others, by whose skill and years of patient labor art has been placed at the service of scientific illustration.

Only through an unprecedented liberality on the part of the publisher of a medical text-book has it been possible thus to re-illustrate an entire department of medicine. To Mr. W. B. Saunders, for his unremitting courtesy, patience, and generosity, we tender our thanks. The Editors desire to acknowledge their indebtedness to Mr. John Vansant for valuable assistance in conducting the mechanical details of the work and for the preparation of the Index.

The plan of this text-book, the exposition of only the latest ideas in pathology, the especial care that directions for treatment shall be particular and full, the avoidance of conflicting statements, and the wealth of illustration, are qualities which, it is hoped, will make this work an efficient guide to those who study or who practise Obstetrics.

RICHARD C. NORRIS,
ROBERT L. DICKINSON.

CONTRIBUTORS.

J. CHALMERS CAMERON, M. D., MONTREAL, CANADA.

Professor of Obstetrics and of Diseases of Infancy, McGill University; Consulting Physician Montreal General Hospital; Physician Accoucheur to the Montreal Maternity, etc.

EDWARD P. DAVIS, M. D., PHILADELPHIA.

Professor of Obstetrics and of Diseases of Infancy, Philadelphia Polyclinic; Clinical Professor of Obstetrics, Jefferson Medical College; Clinical Professor of Pediatrics, Women's Medical College; Visiting Obstetrician to the Philadelphia Hospital; Visiting Physician, Children's Department, Howard Hospital, etc.

ROBERT L. DICKINSON, M. D., BROOKLYN, N. Y.

Lecturer on Obstetrics in, and Obstetrician to, Long Island College Hospital; Obstetrician to Kings County Hospital; Member of the American Gynecological Society, the New York Obstetrical Society, and the Brooklyn Gynecological Society.

CHARLES WARRINGTON EARLE, M. D.,*

Late Professor of Obstetrics in the College of Physicians and Surgeons, Chicago, and of Diseases of Children in the Northwestern University Women's Medical School, Chicago.

JAMES H. ETHERIDGE, M. D., CHICAGO, ILL.

Professor of Gynecology and Obstetrics in the Rush Medical College, Chicago, and in the Chicago Polyclinic; Gynecologist to the Presbyterian Hospital; Consulting Gynecologist to St. Joseph's Hospital, Chicago.

HENRY J. GARRIGUES, M. D., NEW YORK.

Professor of Obstetrics in the New York Post-Graduate School and Hospital; Consulting Obstetric Surgeon to the New York Maternity Hospital; Gynecologist to St. Mark's Hospital and to the German Dispensary in the City of New York.

BARTON COOKE HIRST, M. D., PHILADELPHIA.

Professor of Obstetrics, University of Pennsylvania; Visiting Obstetrician to the Philadelphia, the University, and the Maternity Hospital; Consulting Obstetrician to the Lying-in Charity and to the Preston Retreat; Gynecologist to the Howard Hospital, etc.

CHARLES JEWETT, M. D., BROOKLYN, N. Y.

Professor of Obstetrics and Pediatrics, Long Island College Hospital; Obstetrician to the Long Island College Hospital; Consulting Gynecologist to Bushwick Hospital; Consulting Obstetrician to Kings County Hospital, etc.

HOWARD A. KELLY, M. D., BALTIMORE, MD.

Professor of Gynecology and Obstetrics in the Johns Hopkins University, Baltimore; Gynecologist and Obstetrician to the Johns Hopkins Hospital.

* Deceased.

RICHARD C. NORRIS, M. D., PHILADELPHIA.

Lecturer on Clinical and Operative Obstetrics, University of Pennsylvania; Obstetrician in Charge of the Preston Retreat, Philadelphia; Visiting Obstetrician to the Philadelphia Hospital; Consulting Obstetrician and Gynecologist to the Southeastern Dispensary and Hospital for Women and Children; Gynecologist to the Methodist Episcopal Hospital; Fellow of the American Gynecological Society, etc.

CHAUNCEY D. PALMER, M. D., CINCINNATI, OHIO.

Professor of Obstetrics, of Medical and Surgical Diseases of Women, and of Clinical Gynecology in the Medical College of Ohio; Obstetrician and Gynecologist to the Cincinnati Hospital; Consulting Gynecologist to the German Protestant and Presbyterian Hospitals in Cincinnati, etc.

THEOPHILUS PARVIN, M. D., PHILADELPHIA.

Professor of Obstetrics and of Diseases of Women and Children, Jefferson Medical College; Ex-President of the Indiana State Medical Society, of the Association of American Medical Journalists, of the American Medical Association, of the American Academy of Medicine, of the Philadelphia Obstetrical Society, and of the American Gynecological Society, etc.

GEORGE A. PIERSOL, M. D., PHILADELPHIA.

Professor of Anatomy in the University of Pennsylvania.

EDWARD REYNOLDS, M. D., BOSTON, MASS.

Assistant in Obstetrics, Harvard University; Physician to Out-Patients in Boston Lying-in Hospital; Assistant in Gynecology, Boston City Hospital; Fellow of the American Gynecological Society, the Obstetric Society of Boston, etc.

HENRY SCHWARZ, M. D., ST. LOUIS, MO.

Professor of Gynecology in the St. Louis Medical College (Medical Department of Washington University); Consulting Gynecologist to the Female Hospital; Gynecologist to the Evangelical Lutheran Hospital, etc.

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† The manuscripts of Dr. Earle were revised and completed by Dr. M. J. Mergler.

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AN

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OF

OBSTETRICS.

AN AMERICAN

TEXT-BOOK OF OBSTETRICS.

I. THE GENERATIVE ORGANS.

I. Anatomy of the Pelvis.

Four bones—the two *ossa innominata*, the *sacrum*, and the *coccyx*—take part in the formation of the pelvis; each of these, in turn, is composed of a number of segments which in early life are distinct and united by intervening cartilage. The pieces comprising the innominate bone—the *ilium*, the *pubis*, and the *ischium*—earliest unite, although the union of the several portions of the acetabulum is not complete until from the eighteenth to the twentieth year. The sacral and the coccygeal segments fuse still later, those of the coccyx re-

Fig. 1.—Female pelvis (one-third natural size).

maining movable until middle life, while the attachment of this bone with the sacrum occurs late in life. During the usual period of childbearing, therefore, the segments composing the posterior boundary of the pelvis are ununited, and, in the lower or coccygeal part of the wall, are capable of yielding to the demands of parturition for increased antero-posterior or conjugate pelvic diameters.

The pelvis viewed in its entirety presents an inverted truncated cone (Fig. 1).

2

slightly compressed from before backward, whose base is directed upward and forward, and whose smaller end looks downward and backward. The sacrum and the coccyx occupy a median position behind, and contribute the posterior wall, the innominate bones expanding laterally and meeting in front to form the pubic arch and symphysis.

The space included within these bony walls is divided into two parts by a plane passing through the middle of the sacral promontory behind and the upper border of the symphysis pubis in front. The portion of the body-cavity lying below this plane constitutes the *true pelvis;* the portion lying above this plane, included within the widely expanded iliac bones, the vertebral column, and the abdominal parietes, constitutes the *false pelvis* and belongs to the abdominal cavity, to the contents of which it affords support and protection.

The *true* or *lesser pelvis* is a short curved canal whose *superior strait,* or *inlet,* is marked by the *brim,* a bony ring defined by the anterior border of the promontory of the sacrum behind, the ilio-pectineal lines laterally, and the posterior margin of the pubis in front. The plane of the *inferior strait,* or *outlet,* passes through the tip of the coccyx, the tubera ischii, and the lower border of the symphysis pubis. In addition to the foregoing planes marking the upper and lower boundaries of the true pelvis, two others, corresponding with its widest and most contracted parts, are recognized with advantage.

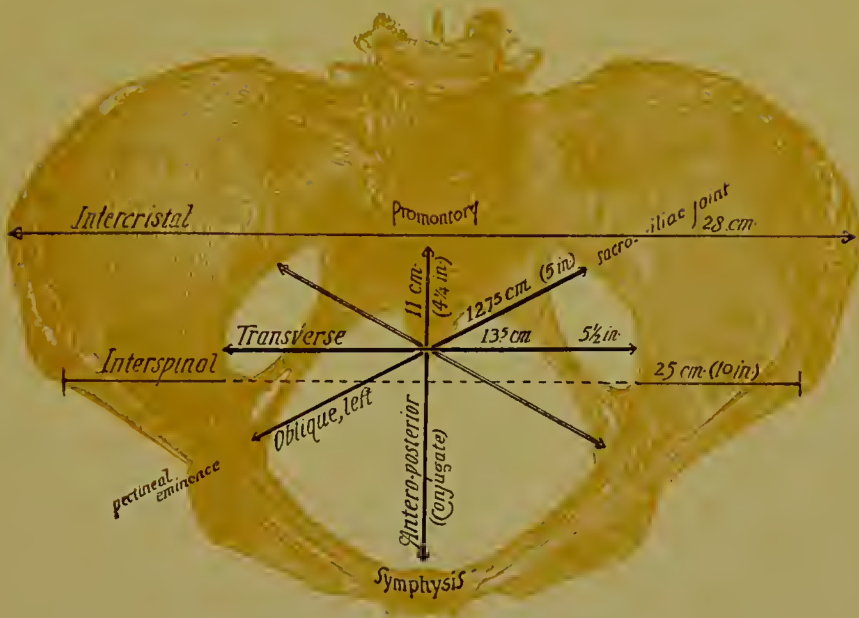
The plane of *greatest pelvic expansion* extends from the union between the second and third sacral vertebræ behind to the middle of the symphysis pubis in front, its lateral boundaries corresponding on either side with the mid-point of the inner surface of the acetabulum.

The plane of *least pelvic diameter* lies somewhat lower, being defined by lines passing through the sacro-coccygeal articulation, the ischial spines, and the lower third of the symphysis pubis: this plane, marking as it does the point of greatest permanent constriction, really constitutes the pelvic outlet in an obstetrical sense more than do the lower and more yielding confines to which the term is usually applied.

The *superior strait,* or *inlet,* of the true pelvis is slightly cordiform in outline, since the low-arched posterior border of its generally oval figure is encroached upon by the sacral promontory, the indentation, however, being much less in the female than in the male pelvis.

The *dimensions of the inlet* (Pl. 2, Fig. 1) are represented by the antero-posterior or conjugate diameter of 11.5 centimeters ($4\frac{1}{2}$ inches), measured from the middle of the promontory of the sacrum to the middle of the upper border of the symphysis pubis, and the transverse diameter of 13.5 centimeters ($5\frac{3}{4}$ inches), determined by the greatest distance between the ilio-pectineal lines; since, however, the pubic portion of the pelvic brim lies slightly in advance of the posterior surface of the pubis, the available antero-posterior diameter, or *obstetric conjugate,* is somewhat less than the anatomical dimension, measuring 11 centimeters (Pl. 2, Fig. 2). Supplementary to these measurements, the oblique diameters of 12.75 centimeters ($5\frac{1}{4}$ inches), measured from the intersection of

The relation between the pelvis and the pelvic organs and the surface of the body: P, promontory of the sacrum; S, symphysis pubis; F, fundus of the uterus; O, the ovary embraced by the Fallopian tube; the line of the psoas muscle indicated; R, the rectum.



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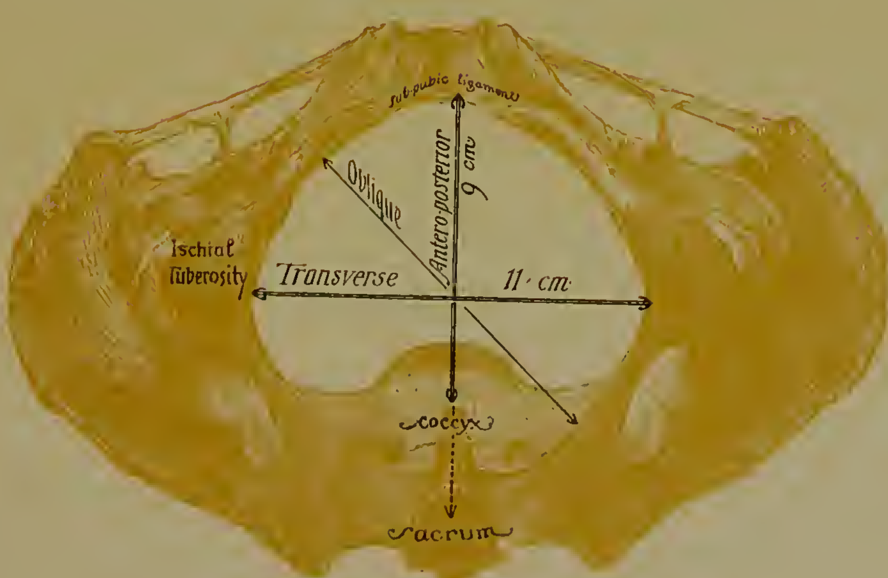


2

1. Diameters of pelvis at brim, with transverse iliac diameters. 2. Diameters of pelvic outlet.

the sacro-iliac articulation with the ilio-pectineal line to the pubic spine of the opposite side, are usually noted. The measurements of the *plane of greatest expansion* include an antero-posterior diameter of 12.75 centimeters ($5\frac{1}{4}$ inches) and a transverse diameter of 12.5 centimeters (5 inches). The *plane of least dimensions* possesses an antero-posterior diameter of 11 centimeters ($4\frac{3}{8}$ inches), as measured between the end of the sacrum and the summit of the pubic arch, and a transverse diameter of 11 centimeters ($4\frac{3}{8}$ inches), taken between the inner surface of the ischial bones near their posterior border; the distance separating the spinæ ischii is about 10.5 centimeters ($4\frac{1}{4}$ inches).

The *inferior strait*, or anatomical outlet, of the pelvis, although less regular in outline than the inlet, possesses a general ovate form, the smaller end of the figure being directed anteriorly, while its larger end is impressed by the prominence of the coccyx; in addition to the latter point, two other osseous projections, the tubera ischii, aid in defining the boundaries of the outlet. Between

FIG. 2.—Female pelvis, viewed from below, with ligaments (one-third natural size).

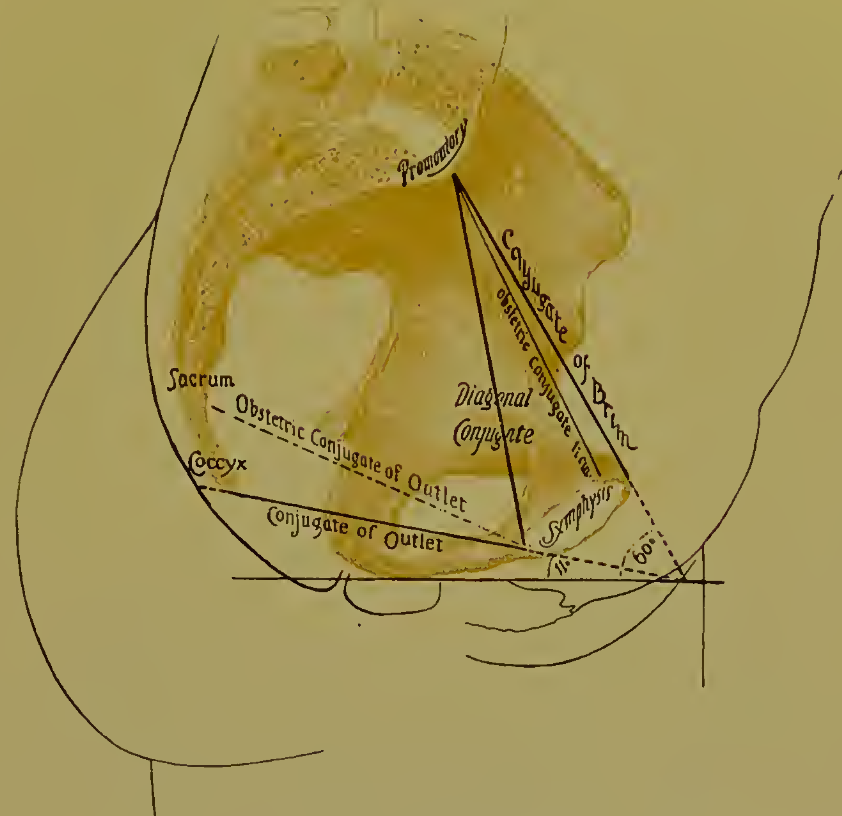
these tuberosities in front is included the subpubic arch, bounded by the pubic and ischial rami, while behind, between them and the sacrum, lie the deep sacro-sciatic notches, which are bridged over and converted into foramina by the greater and lesser sacro-sciatic ligaments (Fig. 2).

The *dimensions of the plane of the pelvic outlet* (Pl. 2, Fig. 2) include the antero-posterior diameter of 9 centimeters ($3\frac{1}{2}$ inches), measured from the tip of the coccyx to the summit of the pubic arch, and the transverse diameter of 11 centimeters ($4\frac{3}{8}$ inches), measured between the middle of the ischial tuberosities. It must be remembered, however, that while the antero-posterior diameter under ordinary conditions is only 9 centimeters ($3\frac{1}{2}$ inches), the mobility of the coccyx is usually such that this diameter, or obstetric conjugate, is increased to 11 centimeters during parturition (Pl. 2, Fig. 2).

The *cavity* of the true pelvis, as appears from the foregoing, is an irregular cylinder of somewhat varying diameter; the imaginary *pelvic axis* is produced by uniting the central points of the antero-posterior diameters of the superior, the inferior, and the intermediate planes above described. The pelvic cavity is enclosed by the smooth surfaces presented by the surrounding bony parts; its anterior wall, formed by the symphysis and the bodies of the pubic bones, is convex and shorter than the posterior, measuring but little more than 4 centimeters (about $1\frac{1}{2}$ inches) in depth; its posterior wall, including the concave anterior surfaces of the sacrum and the coccyx, is much longer, extending 11.5 centimeters (about $4\frac{1}{2}$ inches) from the sacral promontory to the end of the coccyx. The lateral walls correspond with the broad quadrilateral surfaces of the ischial bodies, and present an intermediate depth of 9 centimeters ($3\frac{1}{2}$ inches).

The *position* of the pelvis, evidently, must vary with the changes in the posture of the body. In the erect attitude the plane of the inlet of the true pelvis is well elevated, forming with the horizontal an angle of about 55° (50° to 60°), the inclination being generally somewhat greater in the female; the plane of the outlet coincides more closely with the horizontal, subtending with the latter an angle of about 11° (Pl. 3, Fig. 1). In the erect position the planes of the perpendiculars let fall from the anterior superior iliac spines and from the symphysis pubis coincide; the base of the sacrum lies about 9 centimeters ($3\frac{1}{2}$ inches) above the upper border of the symphysis, the tip of the coccyx at the same time being about 2 centimeters ($\frac{3}{4}$ inch) above the summit of the subpubic arch. The *axis* of the *pelvic inlet* is directed forward and upward, toward the umbilicus; if prolonged downward, it strikes the tip of the coccyx. The axis of the *outlet*, naturally downward and a little backward, will meet the promontory if extended upward. The plane of the symphysis forms an angle of from 90° to 100° with that of the pelvic brim.

The importance of obtaining definite information concerning the dimensions of the pelvis, but, at the same time, the impossibility of determining many of the foregoing measurements on the living subject, has led to the substitution of external, readily accessible measurements which bear a direct and constant relation to the internal diameters. The most useful of these external measurements include—the distance between the anterior superior iliac spines, 26 centimeters; the distance between the iliac crests, 29 centimeters; the distance between the greater trochanters, 31 centimeters; the distance between the spinous process of the last lumbar vertebra and the upper margin of the pubic symphysis, or *external conjugate*, $20\frac{1}{4}$ centimeters; the distance between the posterior superior spinous process and the anterior superior spinous process of the opposite iliac bone, or the *oblique diameter*, 22 centimeters; the distance between the ischial tuberosities, 11 centimeters. These external diameters, which are readily obtained by means of direct measurements by the pelvimeter, bear sufficiently constant relation to the internal diameters to make them of much practical importance. As pointed out by Klein, however, the antero-posterior diameter is subject to considerable normal variation. The average thickness of the bony walls at the points of measurement being known, the subtraction of this amount from the ascertained external diameter evidently



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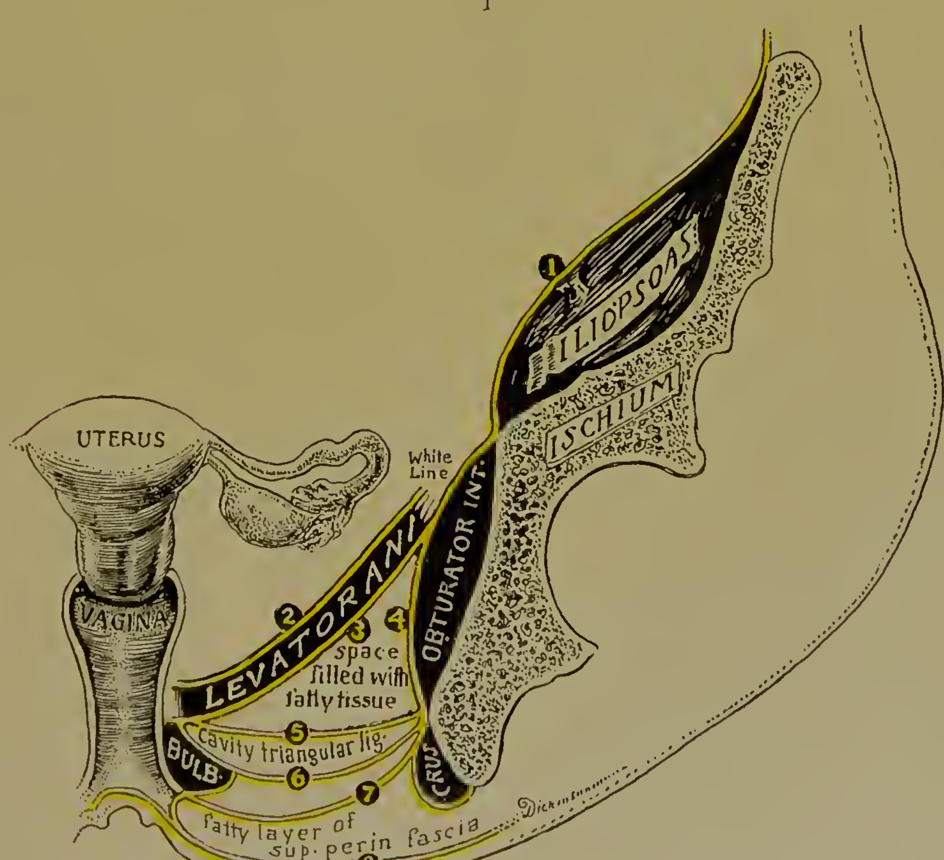

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1. Sagittal section of female pelvis, showing anatomical and obstetrical diameters. 2. Diagram of the structures composing the pelvic floor: 1, pelvic fascia, which at white line splits into recto-vesical fascia (2) and obturator fascia (4), a thin additional sheet, the anal fascia (3), covering the inferior surface of the levator ani muscle; 5, 6, the superior and inferior layers of the triangular ligament; 7, 8, deep and superficial layers of the perineal fascia; 9, skin.

supplies data comparable with the recognized average of the internal dimensions. Thus, the distance between the lower edge of the spinous process of the last lumbar vertebra and the middle of the upper margin of the symphysis, measured by the pelvimeter, is 20 centimeters; from this are deducted the 9 centimeters which represent the combined average thickness of the vertebral body and the pubic symphysis, the remaining 11 centimeters corresponding closely with the conjugate of the superior strait as determined by direct measurement.

The size of the female pelvis, although presenting many individual variations, is not unfavorably influenced by stature, since short women often possess pelves of more than average breadth. The distinctive characteristics of sex are acquired after puberty, although, according to Fehling, indications of these peculiarities are present even at birth. Some asymmetry of the pelvis, as of other parts of the body, is usually to be detected.

FIG. 3.—Male pelvis (slightly less than one-third natural size).

The following table exhibits the average dimensions of the fully developed female pelvis, the measurements being taken from the dried pelvis:

	Centimeters.
Greatest distance between crests of ilia	28
Distance between anterior superior iliac spines	25
Distance between last lumbar spine and front of symphysis pubis	20

TRUE PELVIS.

	Antero-posterior Diameter (Centimeters).	Transverse Diameter (Centimeters).	Oblique Diameter (Centimeters).
Plane of pelvic inlet	11.	13.5	12.5
Plane of greatest expansion	12.75	12.50	
Plane of greatest contraction	11.	11.	
Plane of pelvic outlet	9.5 (increased to 11.5 cm. by displacement of coccyx).	11.	11.5

The *distinguishing characteristics* of the female pelvis (Fig. 1) as contrasted with the corresponding portion of the male skeleton (Fig. 3) include slighter bones with less marked muscular impressions; less height of the entire pelvis; greater breadth and capacity of the true pelvis, but, owing to the more vertically placed iliac bones, relatively and absolutely less expansion of the false pelvis than in the male (Thane). Both the inlet and the outlet are larger in the female, the outline of the pelvic brim approaching more nearly the circular form, owing to the slighter projection of the sacral promontory. In the female pelvis the sacrum is broader and less concave, the depth of the symphysis is less, and the subpubic arch is wider, embracing from 90° to 100° as against 70° in the male.

In addition to individual peculiarities, the influences of race markedly impress the general form of the pelvis, particularly the relation of the antero-posterior to the transverse diameter: the broad, cordiform outline of the Caucasian female pelvis is replaced by one nearly circular among the native Australians; among the Bushman and Malay women the usual ratio between the conjugate and transverse diameters becomes so altered that the outline of the pelvis is an upright oval, the antero-posterior dimension surpassing the transverse.

Articulations of the Pelvis.—The component bones of the pelvis are united with one another by four articulations (Fig. 4): one in front, between

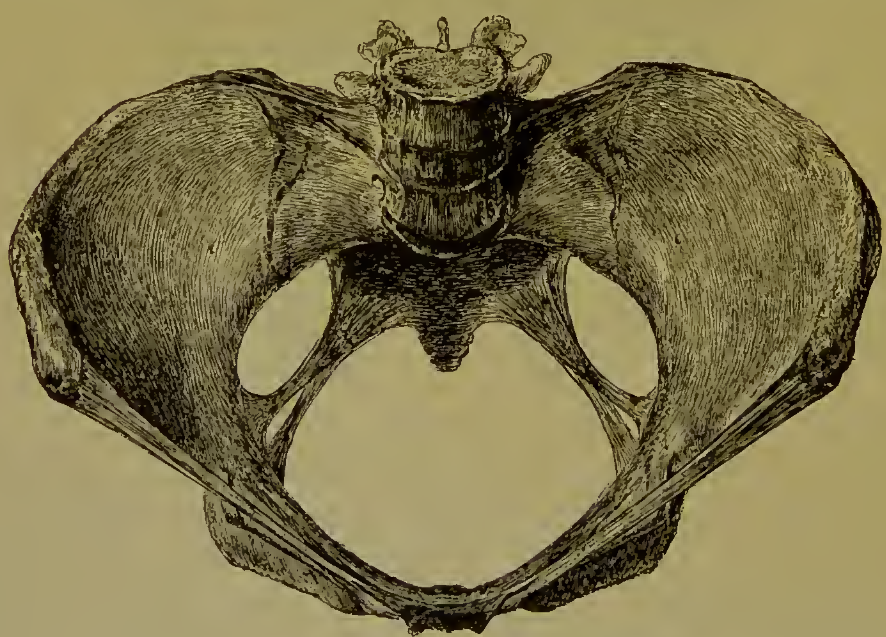


FIG. 4.—Female pelvis (viewed from above) with ligaments (one-third natural size).

the two pubic bones; two behind, between the iliac bones and the sacrum; and one between the sacrum and the coccyx. The opposed bony surfaces are closely united by fibro-cartilaginous plates and external ligamentous bands, and admit of very limited motion; these articulations, therefore, are usually classed as amphiarthroses or symphyses.

The pubic articulation, or *symphysis pubis* (Figs. 5, 6), is formed by the approximation of the two oval articular facets occupying the mesial borders of the pubic bones, which are connected by the interposed fibrous disk and the surrounding external ligaments. The slightly convex surfaces are covered with plates of cartilage which fill up the inequalities of the bones, the opposed surfaces being held together by the intervening mass of fibrous tissue and fibro-cartilage constituting the *interpubic disk* (Fig. 5).

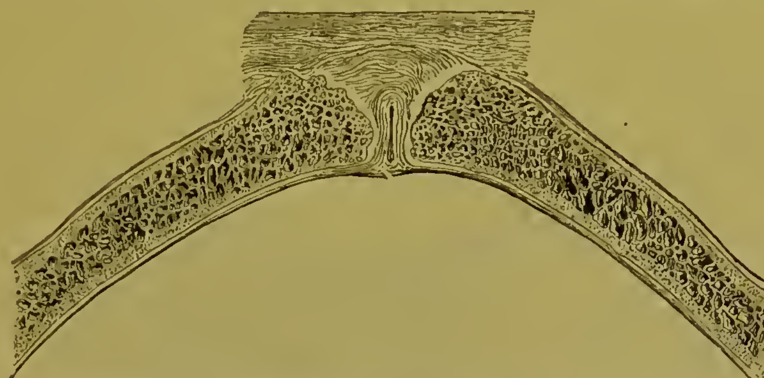


FIG. 5.—Section across symphysis pubis, showing interpubic disk (Lusk).

This layer, which projects anteriorly and posteriorly beyond the adjacent bony margins, is thickest in front; the deficiency of the intermediate tissue above and behind sometimes results in the formation of an interspace or fissure. The fissure within the interpubic disk extends usually about half the length of the cartilage, and is produced during life by the absorption of the fibro-cartilage: it appears after the seventh year, and is of larger size and more constant in the female. While undue tension exerted upon the joint during labor may predispose to the production of this fissure, the latter is not a sequence necessarily of pregnancy, as is shown by its existence in pelves of males and of virgins. A slight separation of the pubic symphysis during pregnancy is regarded by many as probable; this tendency, however, is reduced to a minimum through the bracing effected by the decussating fibres of the oblique muscles. The external ligaments which additionally strengthen this articulation are the anterior, the posterior, the superior, and the inferior.

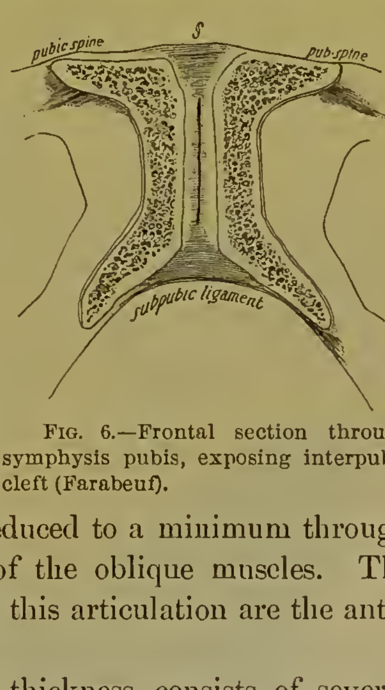


FIG. 6.—Frontal section through symphysis pubis, exposing interpubic cleft (Farabeuf).

The *anterior pubic ligament*, of considerable thickness, consists of several strata of interlacing fibres, the deepest of which passes directly across between the bones in front of the interpubic disk, with which they are blended; the superficial layers include oblique interlacing fibres continued from the tendons of the external oblique and the recti muscles, and of the more superficial adductors of the thigh.

The *posterior pubic ligament* consists of a few sparingly distributed fibres which unite the bones behind, and it is little more than the somewhat thickened periosteum.

The *superior pubic ligament* is represented by a meagre bundle of fibres occupying the upper surface of the articulation.

The *inferior* or *subpubic ligament*, on the contrary, is thick and triangular in form, and it contributes the smooth boundary to the summit of the subpubic arch. Throughout the middle of its span the ligament is closely united

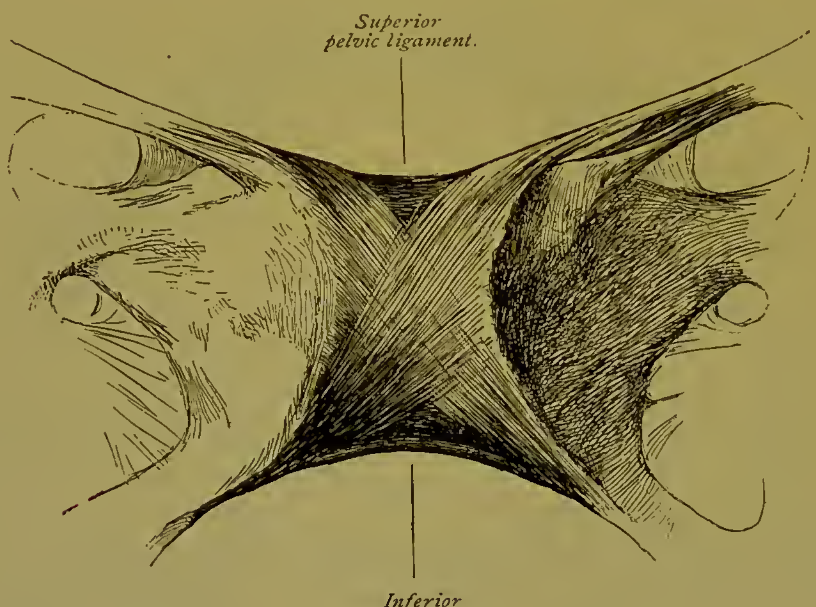


FIG. 7.—Anterior view of symphysis pubis.

with the interpubic disk, being attached at the sides and below to the descending pubic rami (Fig. 7).

The *sacro-iliac articulation* (Fig. 8) lies between the lateral surfaces of the sacrum and the ilium; the rough articular surfaces of both bones are covered by thin plates of cartilage, that on the sacrum being thickest. With the advance of age these cartilages often become roughened and partially separated by spaces containing a glairy fluid. Not infrequently the apposed bones are united by intervening bundles of fibrous tissue, these bands constituting the interosseous ligament. The principal bonds of union are the anterior and posterior ligaments.

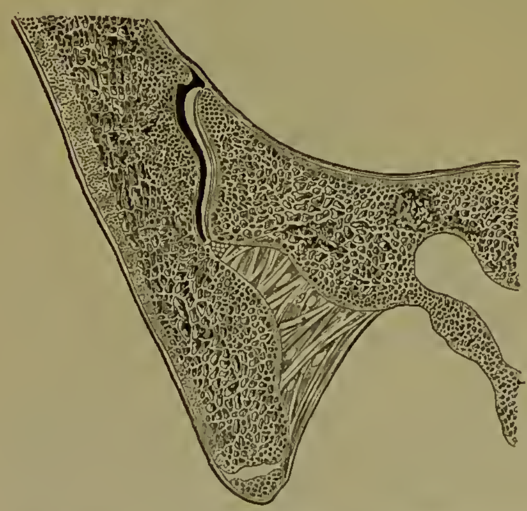


FIG. 8.—Section through the left sacro-iliac articulation (Luschka).

The *anterior sacro-iliac ligament* comprises a number of thin irregular fibrous bundles stretching between the front of the sacrum and the adjacent border of the iliac bone. Associated with the upper and lower margins of this ligament are thickened bundles of fibrous tissue that spread over the ilium respectively as far as the ilio-pectineal line and the posterior iliac spine;

these bands constitute the *superior* and the *inferior sacro-iliac ligaments* sometimes described.

The *posterior sacro-iliac ligament,* which is of great strength, extends between the back of the sacrum and the posterior border of the iliac crest. The general direction of the fibres is downward and inward from the ilium; some of the fasciculi, however, pass almost horizontally, while a special bundle extends nearly vertically from the posterior superior iliac spine to the third and fourth sacral segments, and forms the *oblique sacro-iliac ligament.*

The *sacro-coccygeal articulation* includes the oval facet at the end of the sacrum and the base of the coccyx, and it corresponds in its ligamentous structures with the intervertebral joints, to which series it belongs. The bones are united by the anterior, the posterior, and the lateral bands as well as by the interposed intervertebral disk.

The *anterior sacro-coccygeal ligament* is the continuation of the anterior common ligament of the vertebræ, and it consists of a few irregular bands of fibrous tissue that pass from the anterior surface of the sacrum to that of the coccyx to blend with the periosteum.

The *posterior sacro-coccygeal ligament,* stronger than the preceding, is the prolongation of the posterior common ligament, and it descends from its attachment around the lower orifice of the sacral canal, the lower hind wall of which it largely forms, to the posterior surface of the coccyx.

Additional posterior bands descend from the sacrum to the coccyx as continuations of the interspinous ligaments intimately blended with the aponeurosis of the erector spinæ; the lateral expansions which connect the cornua of

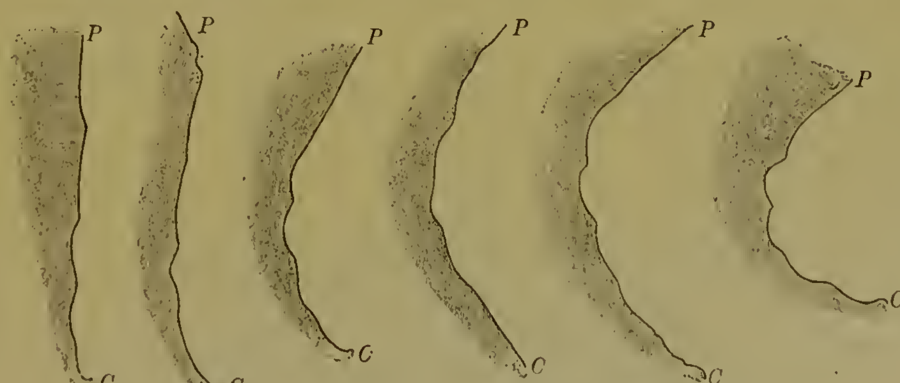


FIG. 9.—Variation in sacral curves (Hirst): *P*, promontory of sacrum; *C*, coccyx.

the last sacral segment to the coccygeal cornua constitute the *supracornual* or *lateral ligaments.* The intertransverse ligament is represented by fibrous bands which pass from the lower lateral angle of the sacrum to the transverse process of the first piece of the coccyx.

The *intervertebral disk* is a rudimentary member of the series of fibro-cartilaginous plates interposed between the vertebræ; a distinct cavity sometimes exists within this disk (Cruveilhier), especially when the coccyx is freely movable; this mobility seems increased during pregnancy.

The coccygeal segments are held together by the extensions of the anterior and posterior ligaments and by the rudimentary intervertebral disks which lie between. The individual pieces remain distinct in the female during early adolescence, but become united by the close of the childbearing period; in later life ossification between the sacrum and the coccyx sometimes takes place.

Closely associated with the boundary of the true pelvis are the important sacro-sciatic ligaments.

The *great* or *posterior sacro-sciatic ligament* extends from the posterior inferior spine of the ilium, the lower tubercles of the sacrum, and the inferior portion of the lateral border of the sacrum and the coccyx to the inner margin of the ischial tuberosity, whence the fibres are continued along the inner edge of the adjoining ramus as the falciform process, the concave border of which affords attachment for the obturator fascia.

The *lesser* or *anterior sacro-sciatic ligament*, triangular in form, passes from its wide attachment on the lateral margin of the sacrum and the coccyx to the spine of the ischium, thus dividing the large space enclosed by the great sacro-sciatic ligament into an upper larger opening, the great sacro-sciatic foramen, and a lower smaller aperture, the lesser sacro-sciatic foramen. The anterior boundaries of these foramina are respectively the greater and lesser sacro-sciatic notches of the innominate bone.

Muscles of the True Pelvis.—The osseous and ligamentous framework of the true pelvis is supplemented by muscles and fascia which complete its boundaries as well as somewhat lessen its capacity, these structures, however, being so located that they but slightly diminish the size of the parturient canal. In order to facilitate a study of the fasciæ, a consideration of the muscles related to the cavity and floor of the true pelvis first claims attention. These muscles, on each side, are four in number—the obturator internus, the pyriformis, the levator ani, and the coccygeus.

The *obturator internus* muscle (Pl. 3, Fig. 2) comes in close relation with the pelvic cavity throughout a considerable part of its extended origin, which includes almost the entire part of the pelvis contributed by the innominate bone. The muscle arises from the inner surface of the obturator membrane, except at its lower part, the fibrous arch completing the canal for the obturator vessels and nerve, and the inner surface of the innominate bone anteriorly and internally between the obturator foramen and the margin of the pubic arch, and posteriorly and externally from the foramen as far as the ilio-pectineal line above and the sacro-sciatic notch behind. The external surface of the muscle rests upon the hip-bone and the obturator membrane; its inner or pelvic aspect is covered by the obturator fascia, the continuation of the pelvic, and comes in relation with the internal pudic vessels and accompanying nerve.

The *pyriformis* muscle arises by digitations from the second, third, and fourth sacral segments between and external to the anterior sacral foramina, from the ilium below the inferior posterior spine, and from the great sacro-sciatic ligament. In its course to the great sacro-sciatic foramen, through which the muscle escapes to seek insertion into the femur, its fan-shaped mass aids in forming the posterior and outer wall of the pelvic cavity.

The remaining two muscles, the levator ani and the coccygeus, are of especial interest, since they largely supplement the fasciæ in the formation of the septum, or *pelvic diaphragm*, which stretches across the bony canal and materially aids in supporting the vagina and the rectum and in the constitution of the floor of the pelvis.

The *levator ani* (Figs. 10, 11), the most important muscle of the pelvic diaphragm, in general, with its fellow of the opposite side, presents the form of a horseshoe, open in front, rather than that of a funnel, as very commonly stated. The true relations of this muscle have especially been emphasized by Luschka

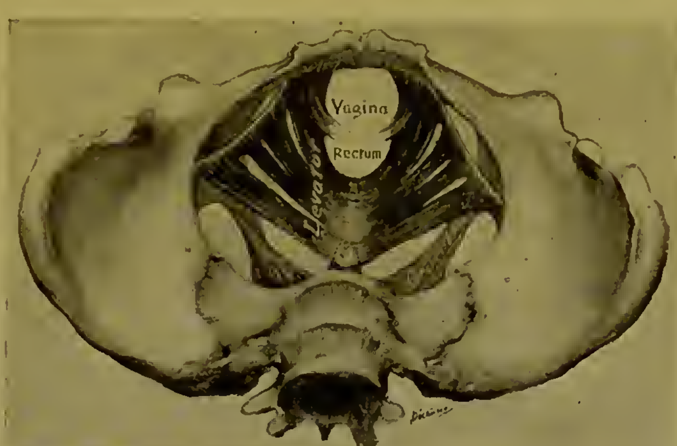


Fig. 10.—Female pelvis, showing the form and attachments of the levatores ani muscles (Dickinson).

and by Dickinson, whose descriptions are here utilized. These two muscles constitute a sling attached to the pubis in front, and, sweeping almost horizontally backward, embrace the vagina and the rectum and become attached posteriorly to the coccyx. While fulfilling the function indicated by its name, the action of

Fig. 11.—Female pelvis, showing the levatores ani muscles from before and below (Dickinson).

the levator ani is especially to drag the lower ends of the vagina and rectum forward to the level of the symphysis. The muscle consists of numerous thin flat bundles often separated from one another by intervals filled by connective tissue, by means of which all are united into a membranous sheet. The origin of the levator ani is partly bony and partly fascial. The bony origin provides for the anterior and posterior portions of the muscle, the intervening and most extended part arising from the tendinous arch which bridges over the obturator internus.

The *anterior portion* takes origin principally from the horizontal ramus of the pubis, about 1.25 centimeters ($\frac{1}{2}$ inch) from the middle of the symphysis, and 3.5 centimeters ($1\frac{3}{8}$ inches) below the upper border of the ramus.

The *posterior portion* is narrow, being little over .5 centimeter (about $\frac{1}{4}$ inch), and arises from the inner side of the ischial spine in front of the origin of the coccygeus.

The broad *intervening portion* of the muscle springs from fascia along a curved line extending from the back of the pubis to the ischial spine, the lowest point of its sweep lying 5.5 centimeters ($2\frac{1}{8}$ inches) below the ilio-pectineal line. This curved line of tendinous origin closely corresponds with the position along which the division of the pelvic fascia divides into the inner recto-vesical lamella and the obturator, the line of separation being marked by thickening of the fascia which produces the tendinous marking or the "white line." The origin of the muscular fibres is by tendinous bands, which may not, however, although closely associated, be directly connected with the line.

The course of the fibres of the various parts of the muscle varies: stretching down and back, the fibres divide into unequal portions, of which one passes to the anterior aspect of the rectum, another to its posterior and lateral surfaces, while the fibres attached to the pubic bone extend along the vagina, with which they are united by strong connective tissue, but do not terminate within its walls. The belly of the muscle sweeps backward, almost horizontally, surrounding the rectum, the margins or edges of the muscular band being often especially thickened; when hypertrophied, as this portion of the muscle sometimes is, severe vaginismus, dyspareunia, and dystocia may result. According to the observations of Dickinson, the inner edge of the levator ani lies about 1.5 centimeters from the vaginal orifice, the position of the muscle being indicated by a sharply defined double band. Contraction of the muscle causes the upper end of the vaginal canal to rise from 15° to 20° toward the pelvic brim. The average muscle exerts a power of ten pounds.

The insertion of the post-rectal part of the levator ani varies with its position: the posterior and smallest part is attached by tendon to the front of the fourth coccygeal vertebra; the middle part becomes aponeurotic and joins its fellow at the tip of the coccyx; and the anterior and largest part unites directly, without tendinous structure, with the muscular bundles of the opposite side.

The *coccygeus* muscle supplements the levator ani behind, presenting a triangular sheet which passes from the ischial spine to the adjacent surfaces of the coccyx and the sacrum. The muscle arises by its apex from the spine of the ischium and from the inner surface of the pelvic fascia, and expands to be inserted by its base into the lateral margin of the coccyx and the lower part of the sacrum. The pelvic surface of this muscle aids in supporting the rectum, and its external surface is closely related with the lesser sacro-sciatic ligament.

Fasciæ of the Pelvis.—The *pelvic fascia* is the direct continuation of the iliac and transversalis fascial sheets. It is attached laterally along the pelvic brim and around the origin of the obturator internus, and behind it extends over the pyriformis and the adjacent nervous trunks as far as the sacrum; anteriorly it closely follows the outline of the obturator internus, aids in bounding the inner opening of the obturator canal, and at the lower part of the pubic symphysis becomes attached to the anterior pelvic wall.

A thickened band of light colored fascia, the so-called "white line" (see p. 28), which extends from the lower part of the posterior surface of the symphysis to the ischial spine, indicates the position along which an inner or visceral

FIG. 12.—Sagittal section showing relations of the several layers of fascia within the pelvic floor (Dickinson).

lamella, the *recto-vesical fascia,* diverges from the parietal or main pelvic sheet; the latter, which adheres to the pelvic wall and covers the obturator internus muscle, is now known as the *obturator fascia;* the latter, therefore, is that part of the parietal lamella of the pelvic fascia that lies below the "white line" and forms the external fascial investment of the ischio-rectal fossa, the deep triangular recess included between the ischial tuberosity and the contiguous parts of the innominate bone and the external and inferior surface of the muscles of the pelvic diaphragm. A thin sheet given off from the parietal layer or obturator fascia below the "white line" covers the under surface of the levator ani muscle and constitutes the *anal* or *ischio-rectal fascia.* The internal pudic blood-vessels and the accompanying nerve in their course across the outer wall of the ischio-rectal fossa are invested by an additional special layer of the obturator fascia, which thus separates the vessels from the fossa and encloses them within Alcock's canal.

The *visceral lamella,* or the *recto-vesical fascia,* is, as pointed out by Webster, a structure of great importance in enabling the pelvic floor to resist inter-abdominal pressure at the pelvic outlet. Springing from the parietal layer along the "white line," the recto-vesical fascia covers the inner and upper surface of the levator ani and continues over the muscle to the bladder, the vagina, and the rectum, where it divides into four layers—the vesical, the vesico-vaginal, the recto-vaginal, and the rectal.

The *vesical layer* expands over the lower lateral aspect of the bladder, forming of that organ the lateral true ligaments, which become greatly thinned out as they pass over its walls. The anterior part of the visceral lamella on each side is attached to the back of the lower part of the pubis in front, laterally to the symphysis, and behind passes to the anterior surface of the bladder to become the anterior true ligament of this organ: the space between these bands, the pubis, and the bladder, sometimes called the "space of Retzius," is occupied by the *retropubic tissue,* consisting principally of adipose and areolar tissue.

The *vesico-vaginal layer* extends between the bladder and the anterior vaginal wall, and aids in connecting these parts by its firm union with both, blending with the attachment of the posterior part of the bladder to the uterine cervix.

The *recto-vaginal layer* passes between the vagina and the adjacent wall of the lower part of the rectum; the union, except behind the upper part of the vagina, is very intimate, while below, this layer is continuous with the fibrous tissue of the perineal body.

The *rectal layer* extends behind the rectum and is attached to its walls, becoming continuous with the corresponding layer of the opposite side.

The Pelvic Floor.—The exact structures which should be regarded as taking part in the constitution of the pelvic floor has occasioned much discussion, since by some authors its constituents are limited to those structures which directly contribute to the continuity of the septum closing in the pelvic outlet, while by others all parts directly or indirectly contributing to the support of this septum, as the bladder, the upper part of the vaginal canal, the uterus, and the rectum, are included within the category of the floor.

In the present consideration of the pelvic floor only those structures will be included that directly contribute to its formation, thus excluding, with Symington, the bladder and the uterus, and reckoning as belonging to the floor only those portions of the walls of the vagina and of the rectum that lie intimately united with the septum. The close relation which these excluded organs bear to the pelvic floor, however, must not be overlooked, since by their intimate connection with the tissues of the floor, on the one hand, and by their suspensory apparatus, on the other hand, they exert an important influence, as emphasized by Webster, in supporting the tissues closing the outlet of the pelvis.

The *pelvic floor*, in the sense here accepted, is bounded externally by the skin and internally by the peritoneum, and includes the several intervening structures which stretch across between the osseo-ligamentous boundaries of the pelvis and enclose the irregular outlet of its cavity. Viewed in mesial sagittal section, the floor is seen to be divided by the vaginal slit into two portions, an anterior and a posterior, which have been designated by Hart, respectively, as the pubic and the sacral segments.

The *anterior* or *pubic segment* appears triangular, being attached to the pelvis in front, and including the structures lying between the symphysis and the vaginal orifice; the urethral and the anterior vaginal walls, together with the dense intervening fibrous tissues, contribute largely to this portion of the floor.

The *posterior* or *sacral segment* includes the structures between the vaginal orifice and the posterior bony pelvic wall, to the sides of which it is closely attached. The portion of this segment interposed between the vaginal slit and the anus constitutes the important *perineal body* (Fig. 13), whose elastic yet resistant tissues enable the septum to undergo great distention during labor. The perineal body is triangular in sagittal section, and its boundaries are the posterior vaginal wall in front, the anterior wall of the rectum behind, and the integument between the vagina and the anus below. The base of the perineal body measures about 2.6 centimeters, and the height from 30 to 36 centimeters. In addition to the strong bundles of fibro-elastic tissue and involuntary muscle that constitute the body, it is traversed by the muscles which join in the common tendinous perineal centre.

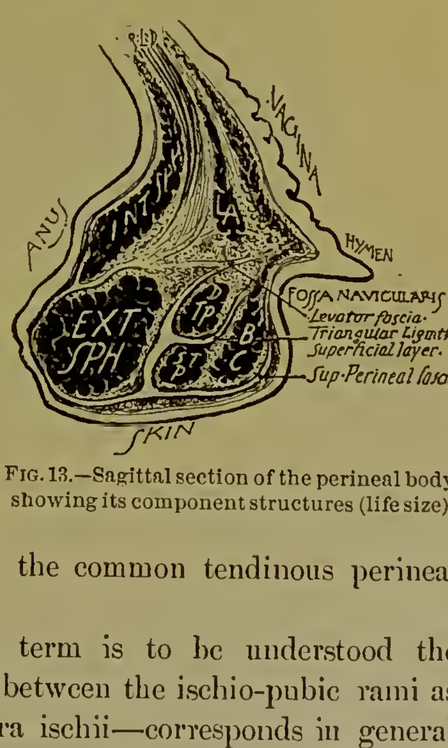


Fig. 13.—Sagittal section of the perineal body, showing its component structures (life size).

The female *perineum proper*—by which term is to be understood the anterior portion of the pelvic floor included between the ischio-pubic rami as far back as a line drawn through the tubera ischii—corresponds in general with the similarly situated structures in the male, subject to the modification brought about by the mesial cleavage of the parts by the vulvo-vaginal opening. The perineum must be distinguished from the perineal body, the latter including only the limited tissues intervening between the vagina and the anus.

As in the male, so also in the female perineum, the fasciæ constitute important and resistant structures (Figs. 14–16). Of these structures there are three: the deep layer of the superficial fascia (corresponding with Colles' fascia), the superficial or inferior, and the deep or superior layer of the triangular ligament. These fascial layers are attached at various levels to the ischio-pubic rami anteriorly and laterally, and converge as they proceed back-

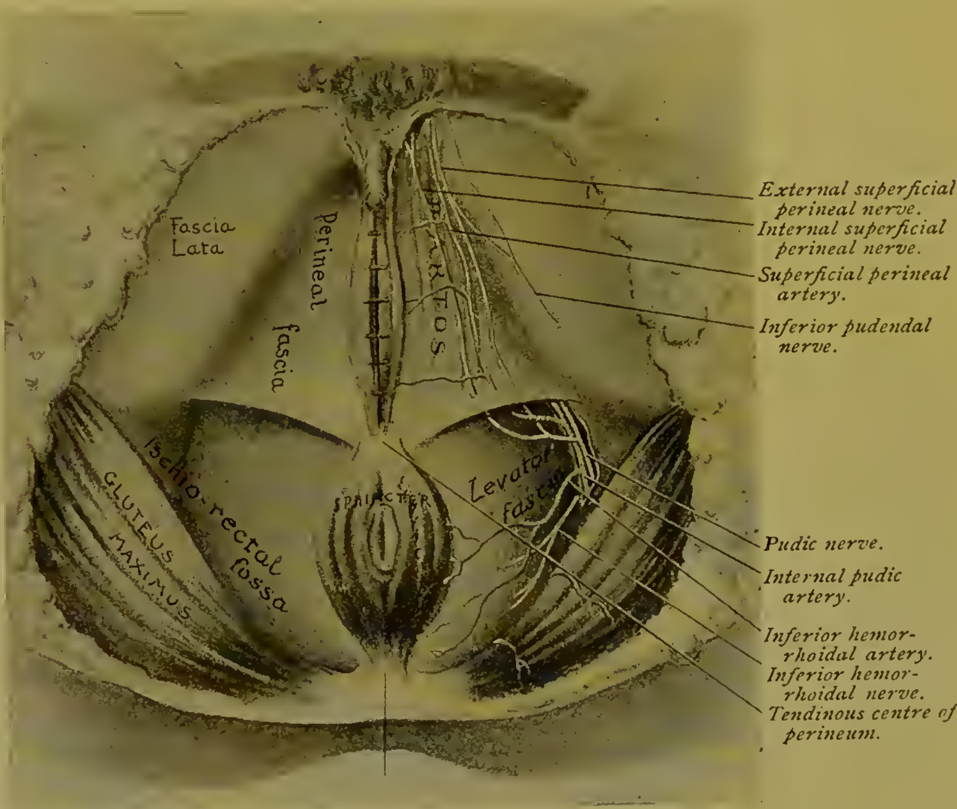


FIG. 14.—Superficial structures of the female perineum (Weisse).

ward to become continuous at the posterior free border of the so-called "perineal shelf," the middle of which marks the perineal centre.

The interval enclosed between the superficial fascia and the superficial or inferior layer of the triangular ligament is divided by the genital orifice into two triangular spaces which together correspond with the *superficial perineal interspace.* The various structures contained within this space include the crura of the clitoris with the associated ischio-cavernosus muscles; the bulbi vestibuli, with the sparingly developed constrictores vaginæ, the homologues of the bulbo-cavernosus; the superficial transversi perinæi; the glands of Bartholin; together with the superficial perineal vessels and nerves.

On removal of the skin and the superficial fascia the *ischio-cavernosus* muscles appear as slender bands which arise from the inner surface of the tuberosities and rami of the ischium and the pubic rami, and converge toward the anterior commissure of the genital fissure, to be inserted into the cavernous bodies of the clitoris, these muscles corresponding closely with those of the male except in size, their reduced dimensions agreeing with the diminutive clitoris.

The *bulbo-cavernosus,* or *constrictor vaginæ* muscle, is represented by attenuated fibres which pass on either side of the vaginal orifice over the bulbi vestibuli and the slender stalks connecting them with the clitoris. The action of these fibres seems to be largely confined to exerting pressure upon the adjacent masses of erectile tissue, with little, if any, direct *rôle* as constrictors of the vagina, compression of this canal being exercised, as already stated, by the contractions of the anterior portions of the levator ani muscle.

The *superficial transversus perinæi* muscles closely resemble those of the male, being, however, reduced in size. They arise from the inner surface of the tuberosities and rami of the ischium, in close relation with the origin of the ischio-cavernosi, and extend inward toward the perineal centre, where they blend with the fibres of the sphincter ani and the constrictores vaginæ.

The roof of the superficial interspace is formed by the *inferior* or *superficial layer* of the triangular ligament, the somewhat thickened anterior part of the

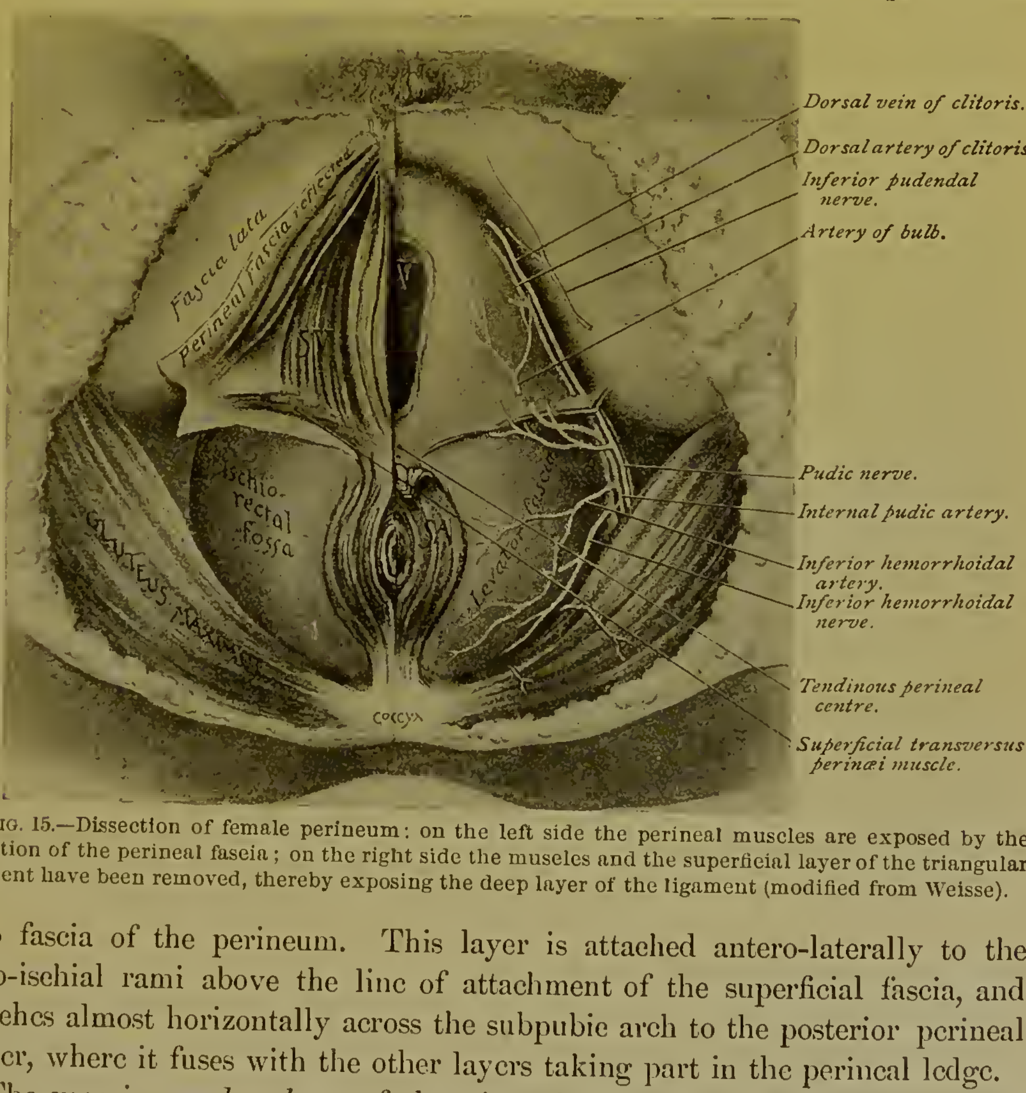


FIG. 15.—Dissection of female perineum: on the left side the perineal muscles are exposed by the reflection of the perineal fascia; on the right side the muscles and the superficial layer of the triangular ligament have been removed, thereby exposing the deep layer of the ligament (modified from Weisse).

deep fascia of the perineum. This layer is attached antero-laterally to the pubo-ischial rami above the line of attachment of the superficial fascia, and stretches almost horizontally across the subpubic arch to the posterior perineal border, where it fuses with the other layers taking part in the perineal ledge.

The *superior* or *deep layer* of the triangular ligament is a resistant fibrous septum which expands inward on each side from its line of attachment along the ischio-pubic rami and constitutes the floor of the anterior extensions of the ischio-rectal fossæ, at the posterior margin of the perineal ledge joining the superficial layer in the common fusion of the fascial layers occurring at that point. This layer may be regarded as a reflection derived from both the obturator and the recto-vesical fascia, since the septum is formed by the union of the contribution given off laterally from the obturator fascia with that supplied mesially by the recto-vesical fascia: this relation is especially evident in frontal sections passing through the ischial tuberosities.

The *deep perineal interspace* lies between the inferior and superior layers of the triangular ligament, and it contains within its wedge-shaped area the urethra and the surrounding venous plexuses, the internal pudic arteries and accompanying veins and deeper nerves, and the fibres of the deep transversus perinæi muscle, here divided by the genital fissure, and represented by thin groups of variable muscular tissue surrounding the urethra.

On removing the skin and fascia, that part of the pelvic floor lying posterior to the perineum proper is divided by a median ridge extending from the

FIG. 16.—Dissection of female perineum, showing the deeper structures after removal of the levator and sphincter ani muscles (much modified from Weisse).

perineal centre to the tip of the coccyx, that consists of the lower end of the rectum surrounded by the deep muscular band of the *sphincter ani externus.* This muscle comprises voluntary fasciculi which extend from the perineal centre in front, where they blend with the fibres of the superficial transverse perineal and vaginal constrictor, to the tip of the coccyx behind, enclosing the anus in their course. Superficially the anal sphincter is closely related with the integument, deeply with the levatores ani and the internal sphincter; the muscular tissue of the rectum is closely related to the external sphincter, since numerous bands of the former blend with the encircling fasciculi of the sphincter. Externally the anal sphincter comes in contact in its deeper parts with the tissue occupying the ischio-rectal fossæ; the latter extend as two deeply receding spaces whose superior boundary follows the lower surface of the levatores ani.

The *ischio-rectal fossæ* are continued anteriorly and posteriorly within the pockets situated respectively above the triangular ligament and the sacro-sciatic ligaments. Viewed in sagittal sections passing through these recesses, the

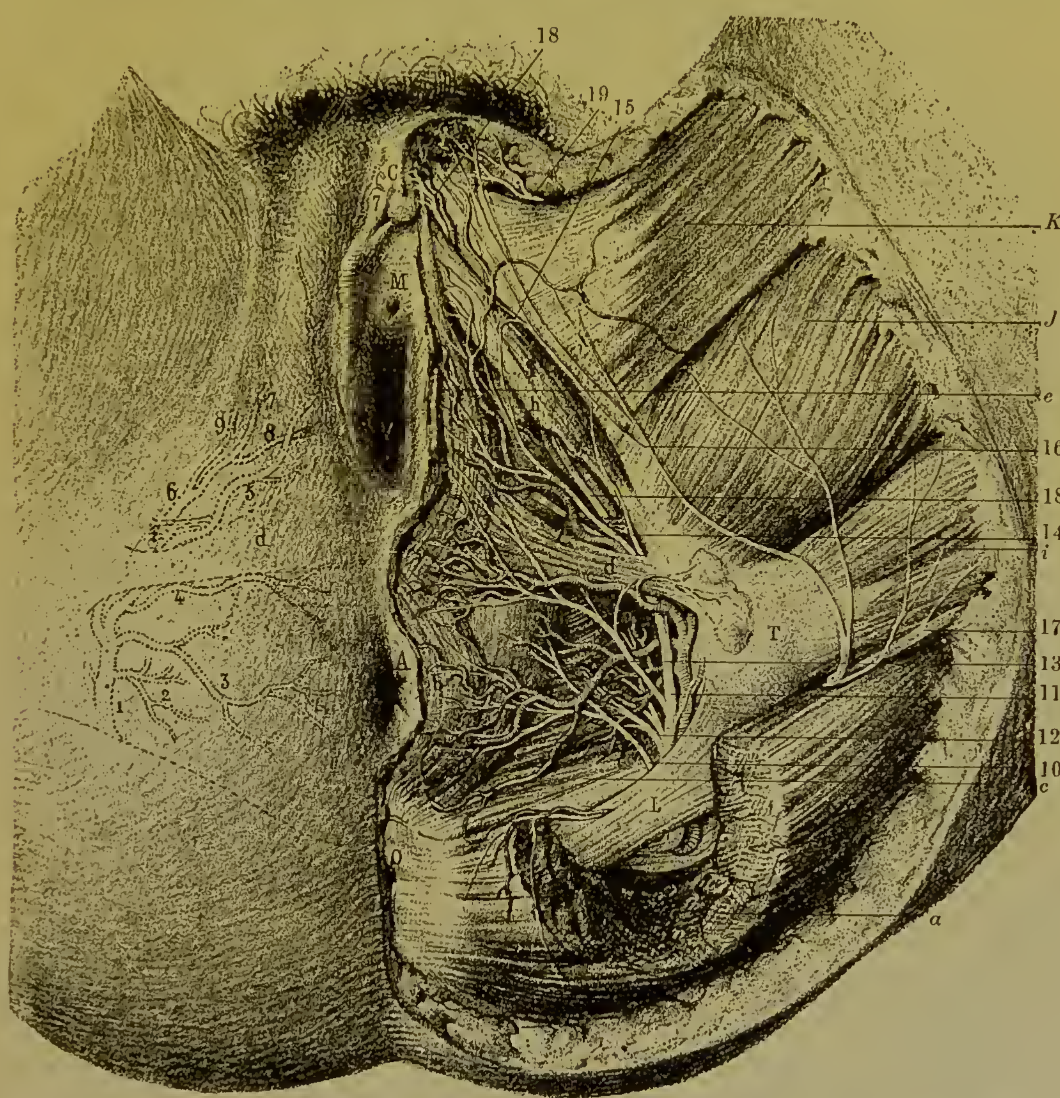


FIG. 17.—Dissection of female perineum, showing superficial blood-vessels and nerves (Savage): *C*, clitoris; *M*, meatus urinarius; *V*, vaginal orifice; *A*, anus; *O*, coccyx; *T*, tuber ischii; *L*, sacro-sciatic ligament; 1, 6, internal pudic artery, giving off its inferior hemorrhoidal (3), cutaneous, and muscular branches (2, 4); 5, superficial perineal; 8, artery of bulb; 7, 9, terminal branches going to dorsum and cavernous bodies of clitoris; 10, pudic nerve; 11, hemorrhoidal and muscular (12) branches; 13, 14, internal and external superficial perineal nerves; 15, communications with inferior pudendal nerve (16); 17, continuation of deep branch of pudic nerve, terminating as dorsal nerve of clitoris (18); 19, terminal twigs of ilio-inguinal nerve; 20, small sciatic; 21, cutaneous branches; *a*, cut surface of gluteus maximus; *b*, sphincter ani; *c*, levator ani; *d*, transversus perinei; *e*, bulbo-cavernosus; *f*, gracilis; *g*, ischio-cavernosus; *h*, expansion of crus clitoridis; *i*, adductor magnus.

ischio-rectal fossa presents an outline, as described by Anderson, not unlike that of an anvil. In frontal sections the fossa appears as an open Λ-shaped recess except at its extreme ends, where, as just described, the perineal ledge and the sacro-sciatic ligaments close in the space below.

The *blood-vessels* of the pelvic floor include the arterial branches derived directly or indirectly from the anterior division of the internal iliac, and the venous trunks accompanying the arteries, as well as the venous plexuses occurring in close relation with the vesico-vaginal walls (Fig. 17).

The inferior vesical and the vaginal arteries, together with twigs from the external pudic, supplement the branches derived from the internal pudic, of which the inferior hemorrhoidal and the superficial perineal especially supply the muscular structures connected with the pelvic floor. The superficial perineal artery pierces the superficial fascia and gains the superficial perineal interspace, supplying the contiguous structures and giving off the transverse perineal branch.

The continuation of the internal pudic artery maintains a more deeply situated course, lying along the lateral boundary of the deep perineal interspace between the two layers of the triangular ligament. In this position are given off the arteries of the vestibular bulbs and of the crura of the clitoris. The internal pudic terminates, after piercing the anterior layer of the triangular ligament, as the dorsal artery of the clitoris, from which twigs extend to the corpus cavernosum, the glans, and the prepuce.

The *veins* of the pelvic floor consist of the trunks which closely correspond with the arteries, of which veins the most important are the tributaries of the pudic vein and those which pursue an independent course and take part in the formation of the rich vesico-vaginal and hemorrhoidal plexuses.

The *nerves* supplying the structures of the floor are derived principally from branches of the sacral nerves, either directly or after their formation of the plexus, supplemented by some few filaments from the ilio-inguinal as well as by numerous branches from the neighboring hypogastric plexus of the sympathetic (Pl. 4).

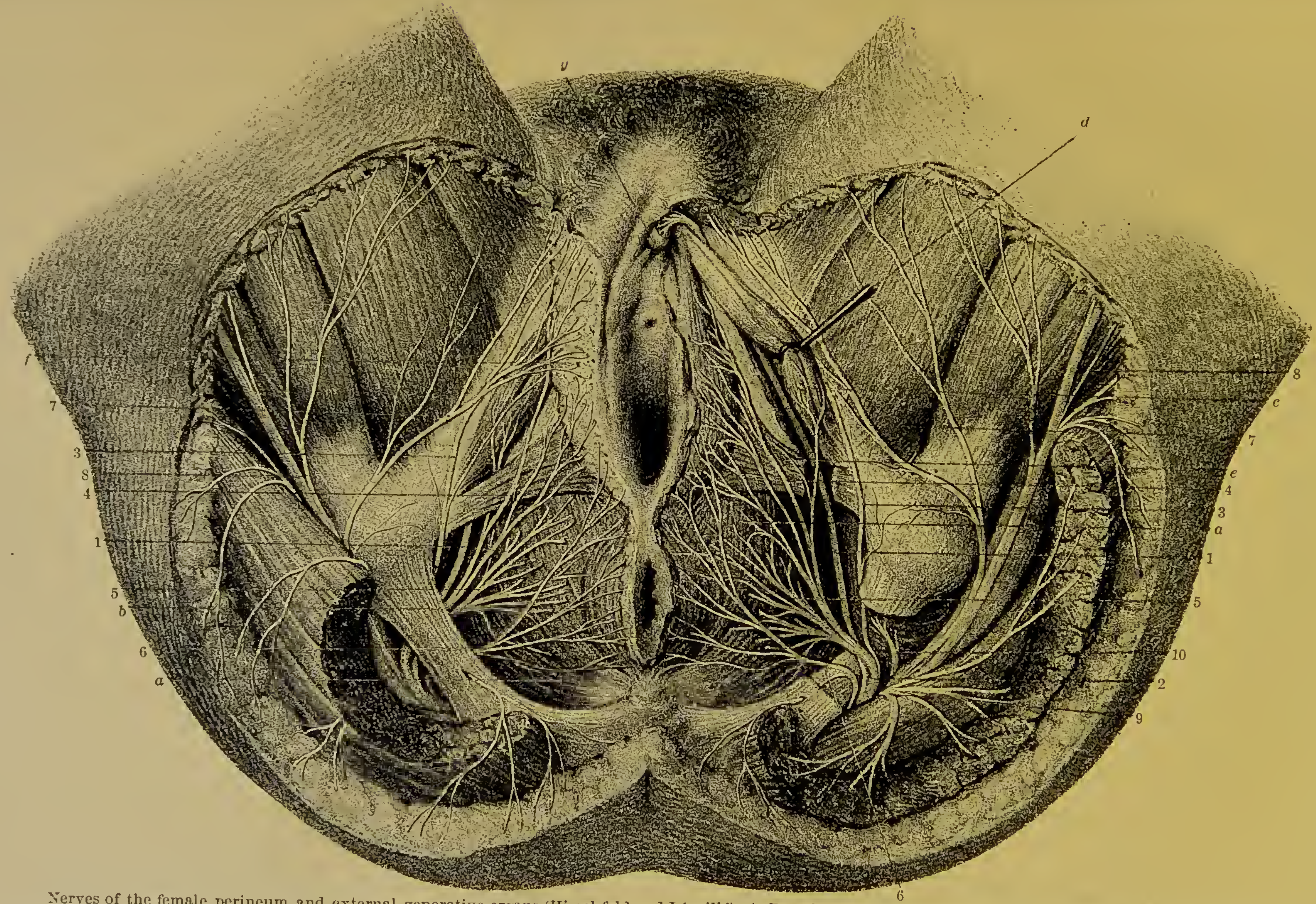
The anterior division of the fourth sacral nerve supplies important muscular structures, including the levator ani, the sphincter ani, and, in conjunction with the fifth sacral, the coccygeus.

The superficial perineal branches of the pudic and the inferior pudendal branch of the small sciatic nerve chiefly provide for the integument and the more superficial structures of the pelvic floor, including the perineal muscles (the ischio-cavernosi, the constrictor vaginæ, and the transversi perinæi) and the more external portions of the genitalia; the ilio-inguinal contributes filaments to the labia. The termination of the pudic nerve passes forward as the diminutive dorsal nerve of the clitoris. Sympathetic filaments from the hypogastric plexus are additionally distributed to those parts containing abundant vascular tissue.

II. Anatomy of the Female Generative Organs.

The structures constituting the female reproductive apparatus consist of three groups—(1) the external, (2) the intermediate, and (3) the internal generative organs.

1. **External organs of generation** (Pl. 5), or the *genitalia*, include the mons veneris, the labia majora and minora, the clitoris, the vestibule with the



Nerves of the female perineum and external generative organs (Hirschfeld and Léveillé): 1. Deep branch and continuation of the pudic nerve in its course to the clitoris (*g*); 2, superficial or perineal branch, which divides into the external (3) and the internal (4) superficial perineal nerves; 5, muscular branches of superficial perineal nerve; 6, inferior hemorrhoidal nerves; 7, inferior pudendal branch of small sciatic (8); 9, muscular branches to glutei; 10, branch to obturator internus; *a*, *a*, the levator ani; *b*, sphincter ani; *c*, constrictor vaginæ; *d*, ischio-cavernosus; *e*, transversus perinæi; *f*, the subcutaneous tissue of the labium majus; *g*, the clitoris.

meatus urinarius, and the vaginal orifice. These parts are collectively known as the *vulva* or *pudendum*.

The *mons veneris* presents an eminence surmounting the pubes in advance of the vulva, and is composed of stout integument abundantly supplied with crisp hairs, and a thick cushion of subcutaneous adipose and areolar tissue upon which the rounded contour of the part depends.

The *labia majora*, the homologues of the scrotum in the male, are two conspicuous longitudinal folds of integument extending from the mons veneris downward and backward to within about 2.5 centimeters (1 inch) in front of the anus. The elongated fissure included between these folds, the *uro-genital orifice*, occupies almost a horizontal position in the erect posture, and is limited by the *anterior* and the *posterior commissure*, formed by the union of the labia in front and behind. Immediately within the posterior commissure a crescentic fold extends transversely and constitutes the *fourchette;* the space between the latter and the posterior commissure is the *fossa navicularis*.

The labia majora are continuous anteriorly with the mons veneris, and are thicker in front than behind; they present the usual appearance of integument, being covered on their outer surfaces with scattered hairs and pigmented epidermis; their protected inner surfaces are more delicate in texture than their outer surfaces, and where least exposed they partake somewhat of the character of a mucous membrane.

The tegmental fold of each labium includes areolar tissue, some involuntary muscle, and a considerable mass of fat which receives the distal end of the round ligament of the uterus. Descent of the ovary into the labium occurs in very exceptional cases, the displaced organ following the round ligament and taking up a position within the labium after traversing the inguinal canal. The labia in the young and well-developed subject are closely approximated and occlude the vaginal orifice.

The *labia minora*, or the *nymphæ*, are two thin diverging folds of delicate skin that lie protected within the greater labia, so that their arched free borders are often completely covered and not visible externally; unless artificially separated their mesial surfaces lie in close contact. The nymphæ are subject to great individual variation in size, in some cases, as conspicuously seen in Hottentot women, reaching excessive dimensions; usually they extend downward and backward from the clitoris (about 3.5 centimeters) along the genital fissure, fading away at the sides of the vaginal orifice. Directly continuous with the labia majora externally, their smooth inner surfaces pass directly into the mucous membrane of the adjacent vestibule, which they closely resemble in appearance and structure. Vascular papillæ and well-developed sebaceous follicles are common to both surfaces of the nymphæ, but sweat-glands, hairs, and fat are wanting. The interior of each fold contains abundant venous spaces, which, in connection with the unstriped muscle present, produce a structure resembling erectile tissue.

The converging and often unsymmetrical labia minora, just before meeting anteriorly, separate into two divisions, the outer and upper leaflets continuing over the clitoris to unite to form the *preputium clitoridis,* the lower or inner laminæ joining below the glands to constitute the *frenum clitoridis.*

The *clitoris,* the homologue of the penis, presents great similarity to the male organ, possessing all the parts of the latter reduced in size and influenced by the absence of the urethra and by the cleft and modified condition of the corpus spongiosum as represented by the bulbi vestibuli.

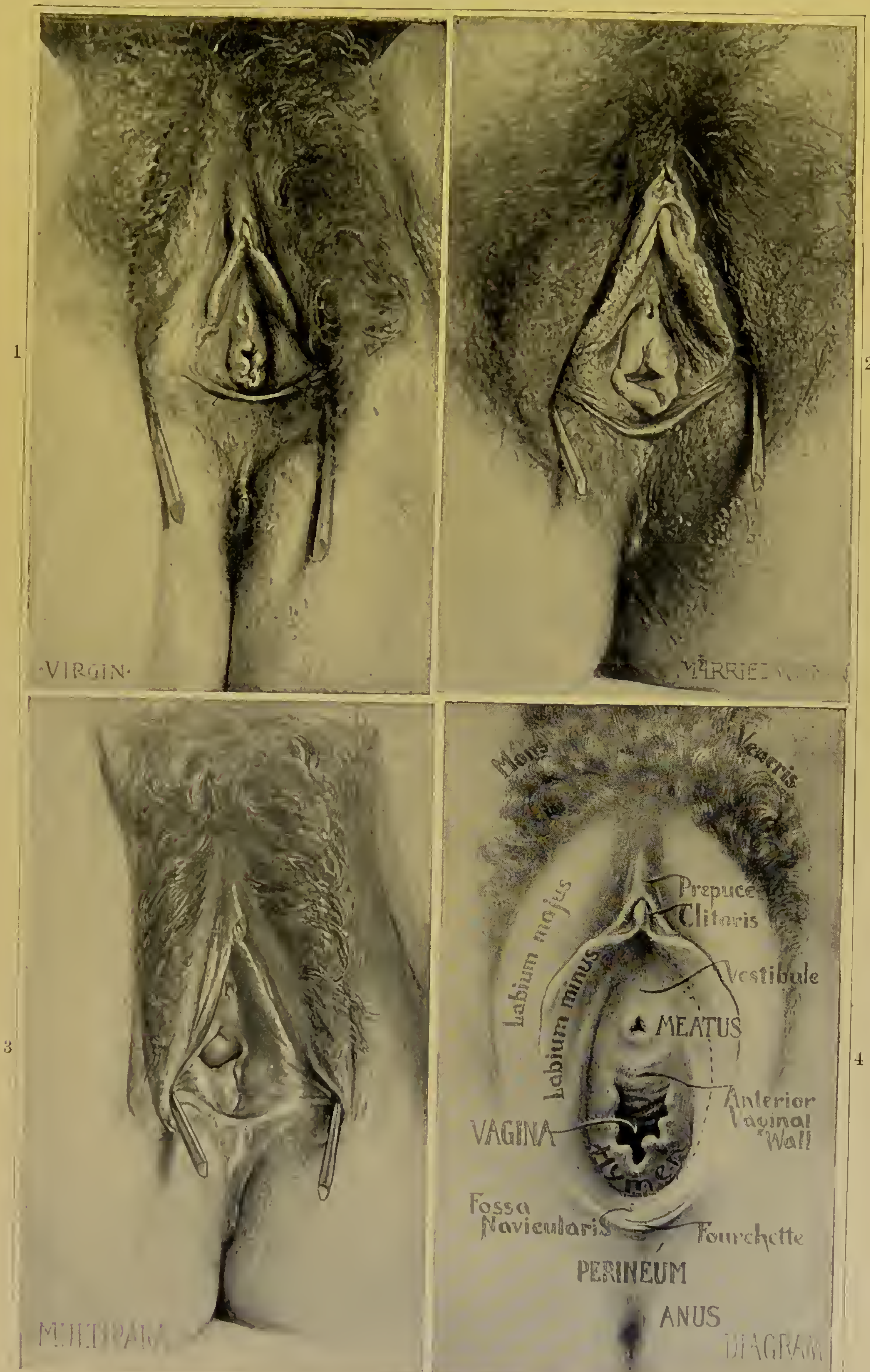
The somewhat laterally compressed body of the clitoris consists of the diminutive *corpora cavernosa,* which diverge behind and are attached by their crura along the pubic and ischial rami, the suspensory ligament aiding in maintaining the position of the organ. In front the cavernous bodies are capped by the rounded *glans clitoridis,* which contains papillæ occupied by arterial tufts and the peculiar special nerve-endings, the *genital corpuscles.* The nerves of the clitoris are relatively better developed than the corresponding ones of the penis, the organ being the especial seat of voluptuous sensation. Sebaceous follicles surround the glans, and they are also present in the outer layer of the prepuce, being almost wanting, however, on the glans itself. These follicles secrete substances prone to decomposition and to the production of a peculiar odor. The erectile tissue constituting the diminutive corpora cavernosa and the glans corresponds in structure with similar tissues within the penis. Two small muscles, the ischio-cavernosi or erectores clitoridis, extend from the ischial tuberosities to be inserted in the crura of the clitoris, and correspond with the homologous muscles of the male.

The *vestibule* includes the triangular space lying between the clitoris in front, the vaginal orifice behind, and the nymphæ at the sides. Its smooth mucous surface is broken by the urethral opening, the *meatus urinarius* being situated in the mid-line of the posterior vestibular wall about 2 to 2.5 centimeters (1 inch) behind the clitoris, slightly in advance of the orifice of the vagina.

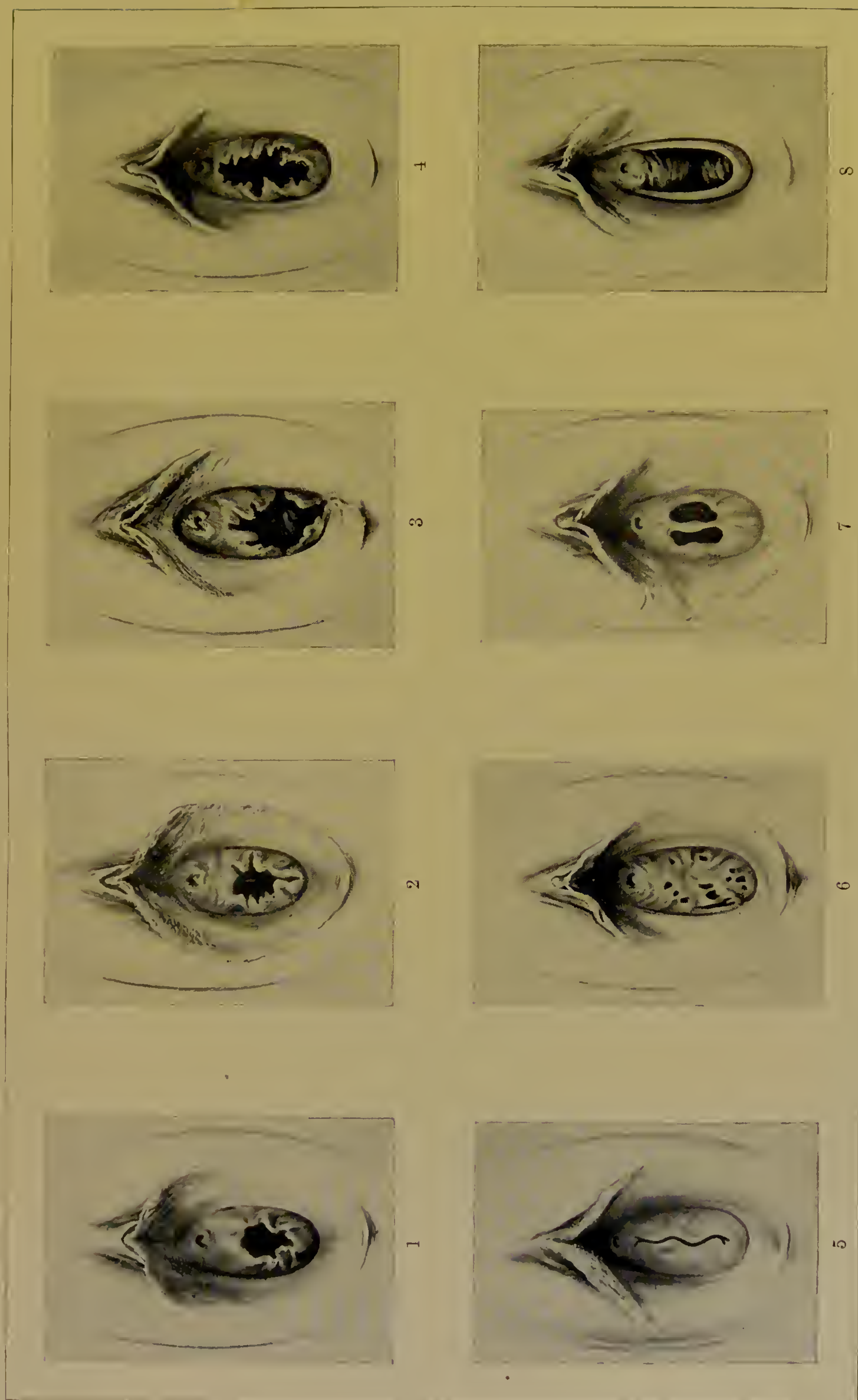
The *urinary meatus* varies in form, but oftenest appears as an ovoid cleft, frequently presenting short irregular lateral branches, surrounded by a border of slightly corrugated elevated mucous membrane, due to the encircling ring of muscular fibres (Pl. 5).

The *bulbi vestibuli* are two elongated leech-shaped masses (about 2.5 centimeters in length) situated on either side of the vestibule a little behind the nymphæ, and attached above to the crura of the clitoris by means of a contracted intermediate portion, the *pars intermedialis.* They are composed principally of close and intricate venous plexuses corresponding with the tissues of the male corpus spongiosum, of which part the bulbi vestibuli must be regarded as the cleft homologue. The constrictores vaginæ muscles lie in close relation with the bulbs, and by their contractions, as during sexual excitement, compress the venous channels and render the tissue turgid and erect.

The *glands of Bartholin,* the homologues of Cowper's glands, are two round or oval yellowish bodies (about 1 centimeter in diameter) which lie on either side of the lower part of the vagina. These bodies are less deeply situated than the corresponding structures in the male, being contained within



1. Virgin hymen. 2. Characteristic hymen and fourchette of a married woman; large wrinkled labia minora and prepuce. 3. Multipara, showing remnant of hymen, pouching anterior and post-vaginal wall, scar in perineum, large labia majora. 4. Diagram on a different scale from the preceding figures.



VARIETIES OF HYMEN: 1. Virgin hymen, commonest form (annular); 2, hymen after coitus; 3, after delivery; 4, fimbriate hymen; 5, hymen with narrow slit; 6, cribriform hymen: 7, hymen with septum; 8, horseshoe form.

the superficial perineal interspace, and not between the two layers of the triangular ligament. They are muco-serous racemose glands, and pour their secretion upon the mucous membrane by long slender ducts which, after an oblique course, open into the vestibule just external to the vaginal orifice.

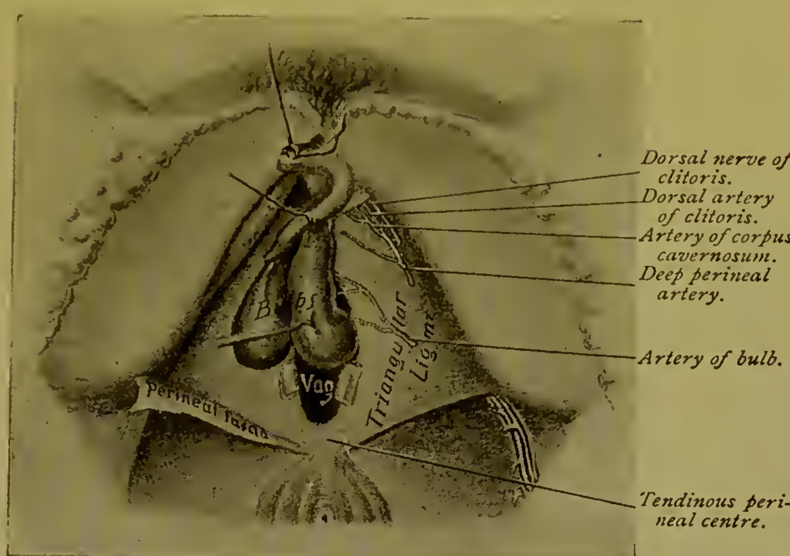


FIG. 18.—Dissection of female perineum, showing the vestibular bulb and the clitoris (Weisse).

The *hymen* consists of a thin, usually crescentic duplicature of mucous membrane, strengthened by fibrous tissue, stretched across the posterior part of the vaginal opening, which it partly occludes. The hymen varies greatly in form and in extent, at times being represented by a slight semilunar fold

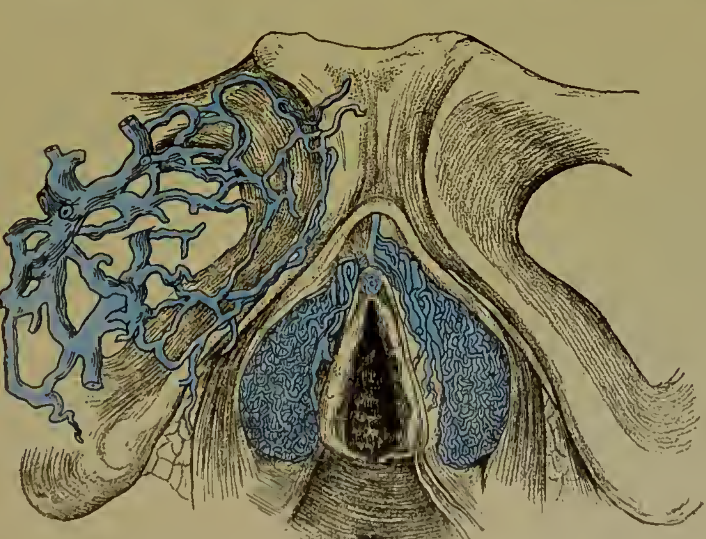


FIG. 19.—Erectile structures of the female genitalia, particularly the highly vascular bulbi vestibuli (Kobelt).

whose concavity looks upward toward the pubes, at other times forming almost a complete and imperforate membranous septum. The variations in the shape and extent of the fold and its orifice include the circular, cleft-like, cordiform, cribriform, and other types, well illustrated on Plate 6. Rupture of the hymen usually, but by no means necessarily, occurs during the first sexual intercourse; in rare cases the septum persists until the event of parturition. In women who have borne children the orifice of the vagina is surrounded by irregular papillary elevations, the *carunculæ myrtiformes:* these are the remains of the ruptured hymen, but are usually present only after labor has taken place, since, as established by Schroeder, the rent hymen is converted into these eminences as the result of the pressure incident to childbearing, and not to coitus.

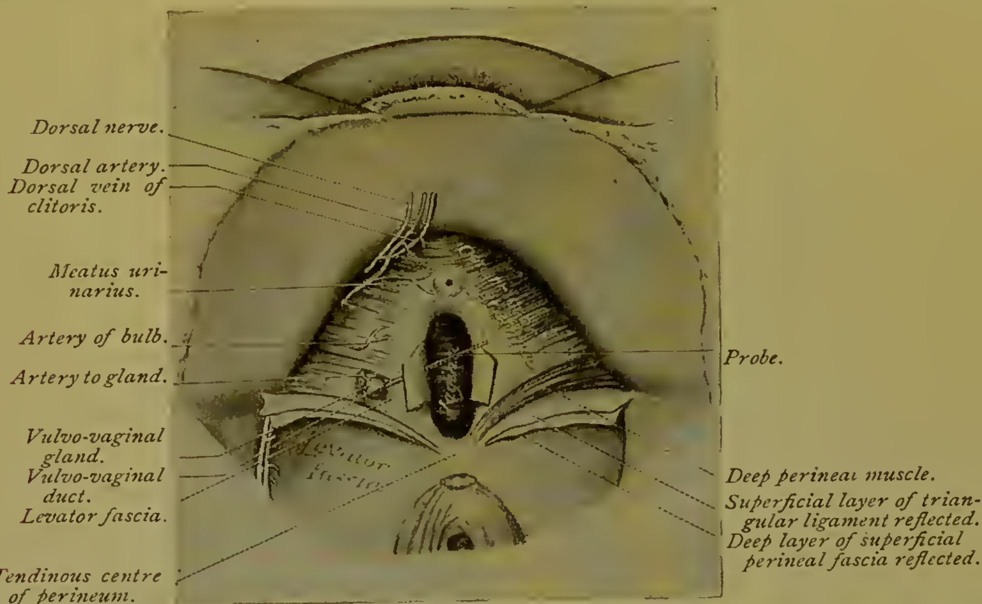
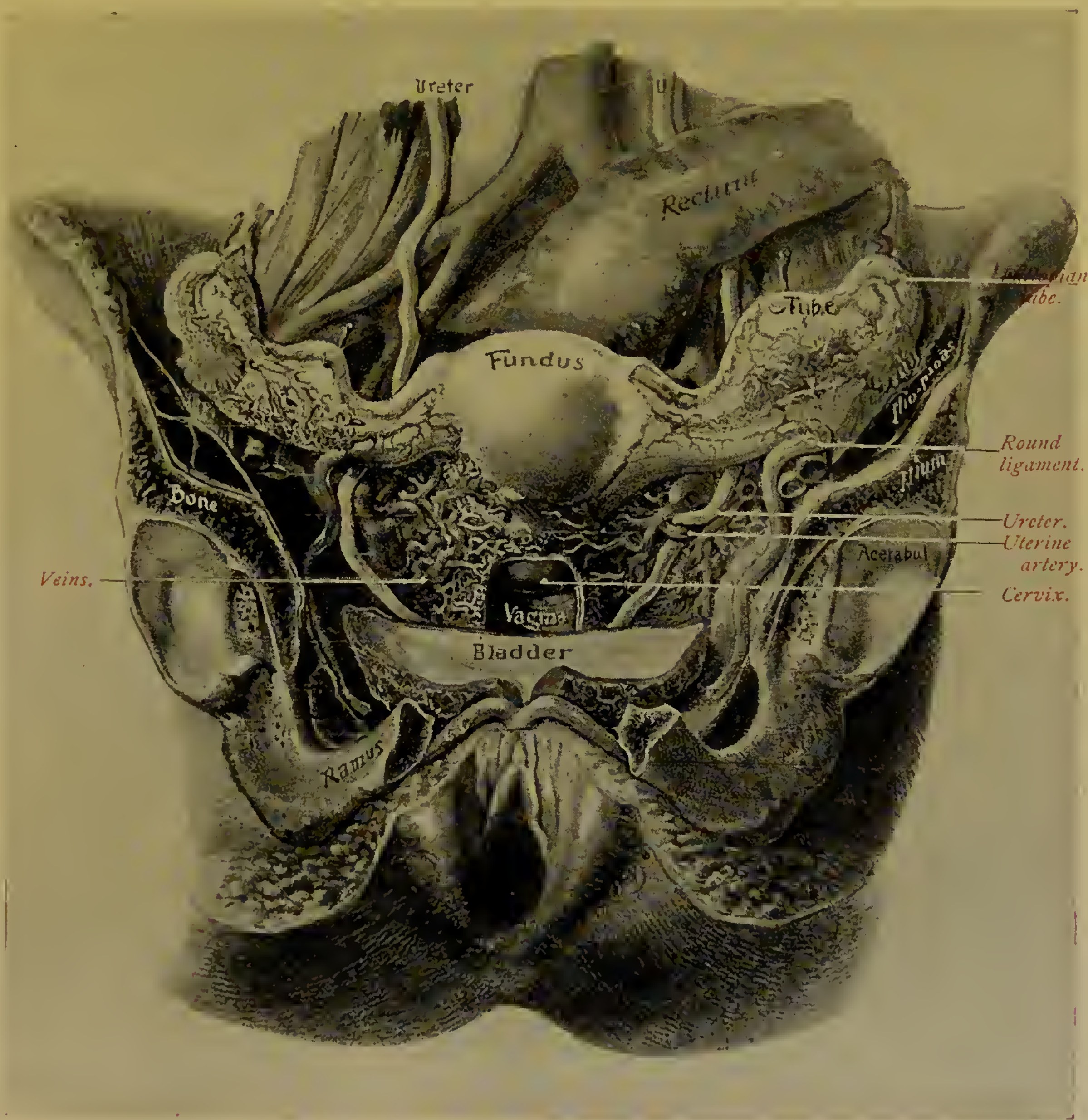


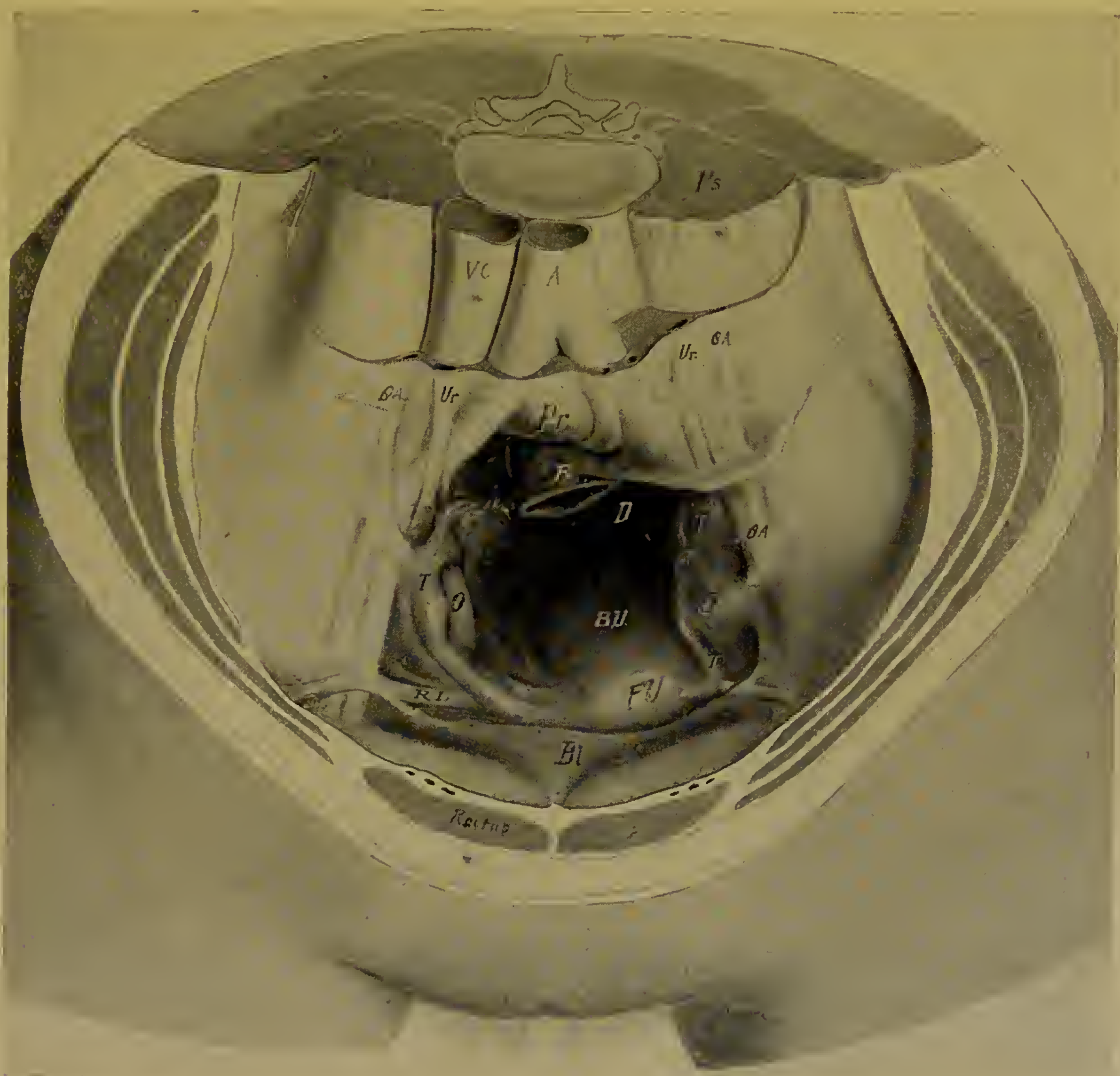
FIG. 20.—Dissection of female perineum, showing structures within the deep interfascial perineal interspace; the vulvo-vaginal glands, however, belong to the superficial space, but are shown resting on the deeper structures (Weisse).

The *female urethra* (Fig. 21) is short, being only about 4 centimeters in length, and lies beneath the symphysis pubis, firmly imbedded within the anterior vaginal wall. It descends from the neck of the bladder to the vestibule almost vertically, presenting usually, however, a slightly marked double or sigmoid curve, or at least a curvature, forward. Its vestibular orifice, the *meatus urinarius*, is indicated usually by an elevation of the mucous membrane situated from 2 to 2.5 centimeters behind the clitoris. The meatus marks the most constricted part of the canal, the average diameter of which is about .6 centimeter. Owing to the elastic character of its tissues and to the yielding nature of the surrounding structures, the female urethra is capable of great distention, a matter of importance in examination of the bladder.

The walls of the urethra comprise a mucous, a submucous, and a muscular layer. The mucosa is covered by stratified squamous or transitional epithelium directly continuous with that of the bladder; tubular glands occur near the vesical end of the canal, where the mucous membrane is soft and spongy. Skene has called attention to the existence of two small tubes (from 10 to 20 millimeters in length) which lie within the muscular walls of the female urethra and which open by minute orifices situated about 3 to 4 millimeters within or above the meatus. These tubes probably represent the remains of Gärtner's duct derived from the fetal Wolffian duct.



Blood-vessels of the pelvis (Bourgery and Jacob): the anterior part of the pelvis has been removed, and the bladder and the anterior vaginal wall have been partially cut away. The uterus is drawn up and the Fallopian tubes are displaced into the iliac fossæ.



Pelvic organs *in situ* of a young woman of sixteen years; seen from above after careful removal of the intestines without disturbing the relations: *A*, abdominal aorta; *VC*, inferior vena cava; *Ps*, psoas magnus; *Pr*, promontory of sacrum; *R*, cut rectum; *D*, pouch of Douglas; *BU*, body of uterus; *FU*, fundus of uterus; *Bl*, bladder; *O*, ovary; *T*, Fallopian tube; *RL*, round ligament; *Ur*, ureter; *OA*, ovarian artery (redrawn from Waldeyer).

The submucous stratum contains much elastic tissue and a rich venous plexus. The muscular tissue of the bladder is continued over the urethra as an inner longitudinal and an outer circular layer, in addition to which the tube receives an investment between the layers of the triangular ligament from the compressor urethræ or deep transverse perineal muscle. The numerous blood-vessels and nerves of the female urethra are derived from the same sources as those of the vagina.

The *female bladder*, relatively broad and capacious, bears important relations to the vagina and the uterus. When empty and relaxed the organ lies entirely within the true pelvis, behind the pubes and usually to one side; the fundus is then greatly flattened out and somewhat indented, so that the cavity of the bladder and the urethra together appear Y-shaped in section (Fig. 22), the widely-separated hinder limb and the corresponding posterior vesical wall lying against the upper part of the vagina and the lower segment of the uterus;

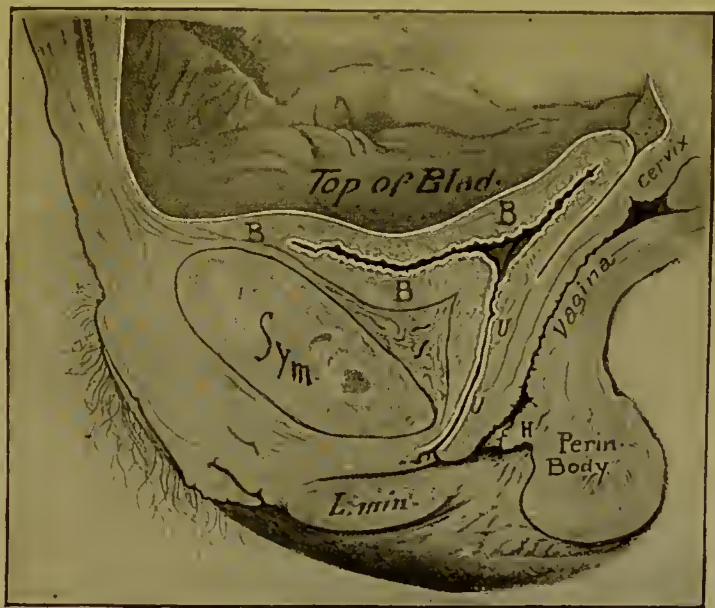


FIG. 21.—Sagittal section, showing relations and form especially of the bladder, urethra, and vagina (Hart): *U, U*, urethra; *B, B*, bladder.

sometimes, however, the empty organ is strongly contracted, the cavity of the bladder then presenting a slit-like lumen. Maximum distention carries the bladder, together with the peritoneum, well above the pubes, with the consequent tendency to backward displacement of the uterine fundus.

The Female Ureter.—The ureter in the female (Pls. 7, 8) presents peculiarities in its relations within the pelvis that deserve notice. After the usual relations of the abdominal portion of its course—proceeding downward and inward upon the psoas muscle and its fascia, being crossed by the ovarian vessels, and crossing the iliac vessels about 1.5 centimeters below the division of the common iliac artery—the ureter passes into the true pelvis in front of the sacro-iliac synchondrosis, thence upon the obturator internus muscle and its fascia toward its termination, running beneath the root of the broad ligament.

About opposite the origin of the vesical and uterine arteries from the internal iliac, the ureter forms a sweeping curve which is most pronounced where the uterine artery crosses the ureter, about on a level with the os externum. The ureter crosses the uterus at a point closely corresponding with the position of flexure of the uterine body upon the cervix, here lying between the vesical venous plexus laterally and the utero-vaginal venous plexus and the uterine artery internally.

The lower part of the ureter passes at first at the side of the upper third of the vagina; it then reaches the vesico-vaginal septum, within which it lies for 1.5 to 2 centimeters before entering the bladder-wall.

The ureter does not extend lower than about the middle of the anterior wall of the vagina; as it rests directly upon the latter, it is enclosed for a

FIG. 22.—Mesial section, showing the relation of the viscera in their normal position (Dickinson).

short distance (about 1 centimeter) within a distinct fibrous sheath continuous with the bladder-wall (Waldeyer).

The course of the ureter within the vesical wall is obliquely downward and inward for a distance of about 1.5 centimeters. The lower part of the tube, from its investment by the above-mentioned sheath to its termination, is cylindrical in form, in contrast with the remaining flattened portions of the canal.

2. Intermediate Organ.—*The Vagina.*—The musculo-membranous canal of the vagina forms the intermediate tract connecting the internal and the

external organs of generation. Piercing the pelvic floor with its lower end, it lies chiefly within the cavity of the pelvis, in relation with the bladder and the urethra in front and with the rectum behind, the *vesico-vaginal* and the *recto-vaginal septa* intervening. The axis of the vagina (Fig. 23), while corresponding in general with that of the pelvic cavity, resembles that of the urethra and the rectum in presenting a double or S-like curvature. The axis of the lower third of the vagina corresponds closely with the plane of the pelvic brim; that of the upper two-thirds lies parallel with the axis of the lower third of the rectum, forming almost a right angle to the axis of the anal extremity of the gut.

The two principal vaginal walls, the anterior and the posterior, ordinarily lie in contact except at the sides, where the lumen of the canal laterally

FIG. 23.—Sagittal section of female pelvis, showing axis of the vagina.

expands. In cross-section, therefore, the vaginal passage under normal conditions appears H-shaped (Fig. 24); when distended it is club-shaped, being more capacious above than below, where the entrance marks the least diameter.

The shorter *anterior wall* (Fig. 25) extends from the vaginal entrance to the apex of the corresponding utero-vaginal recess or *anterior fornix*, and measures about 6.5 centimeters, or about $2\frac{1}{2}$ inches; seen from behind, this surface appears triangular in its general form, the base being above, corresponding with the greater superior diameter of the canal. The anterior wall is very conspicuously marked by transverse *rugæ* (Fig. 26), which are especially prominent in the virgin; an additional vertical fold, the *anterior column*, is present at the lower part of the passage, where, also, this wall, distinctly thicker than its fellow, is most robust.

The *posterior wall*, much the longer, extends from the vaginal orifice or the hymen to the apex of the deep *posterior fornix* (Fig. 25) or retro-cervical fossa; it lies in front of the anterior rectal wall, with which, throughout its lower two-thirds, it is united by areolar tissue. The posterior wall measures about 9 centimeters, or about $3\frac{1}{2}$ inches, in length, being broader above than below; its superior third receives an imperfect covering of the peritoneum which forms the most dependent portion of the anterior wall of Douglas's pouch. While distinctly less corrugated than the anterior wall, the posterior surface in the virgin possesses numerous transversely disposed rugæ as

FIG. 24.—Section illustrating the characteristic form of the vaginal cleft (Henle): *Ua*, urethra· *Va*, vagina; *L*, levator ani; *R*, rectum.

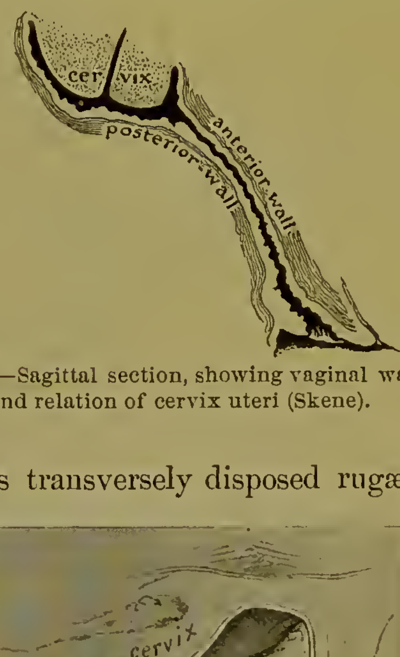


FIG. 25.—Sagittal section, showing vaginal walls and relation of cervix uteri (Skene).

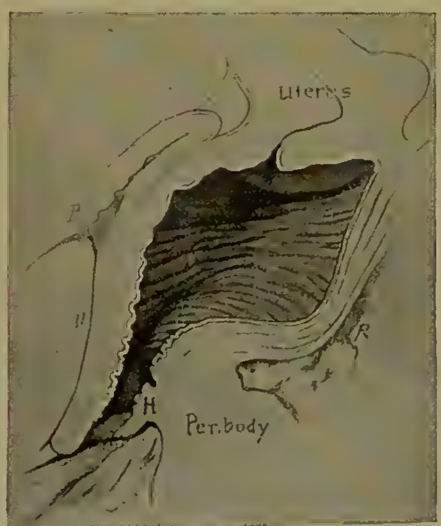


FIG. 26.—Sagittal section of vagina of a virgin, showing rugous condition of walls and enlarged upper extremity (Hart).

FIG. 27.—Sagittal section of vagina of a multipara, one-half natural size (Hart).

well as a vertical, and sometimes double, posterior column. Subsequent to the dilatation incident to parturition the vaginal rugæ are much less conspicuous

(Fig. 27), those on the posterior wall often almost entirely disappearing, leaving the somewhat pouched surface relatively smooth; the folds of the anterior wall are retained to a much greater extent.

In *structure* the walls of the vagina consist of a mucous membrane, a muscular coat, and a fibrous tunic. The *mucosa* is covered by a thick stratified, squamous epithelium, and possesses numerous papillæ. The rugæ include within their structure not only the tissues of the mucosa, but also bundles of involuntary muscle and large veins. True *glands,* if found at all, are represented by a few sparingly distributed tubular structures within the upper part of the vaginal mucous membrane, the acid secretion which bathes its surface being the product of the general mucosa. The deepest part of the mucous membrane, that corresponds with the *submucous layer,* is succeeded by the *muscular coat,* composed of an inner circular and an outer longitudinal stratum of unstriped muscle.

The *fibrous tunic* consists of a dense coat, rich in fibro-elastic tissue, which is derived as a prolongation of the recto-vesical fascia and materially contributes to the strength of the vaginal wall. The lower extremity of the canal is encircled by a thin plane of muscular fibres constituting the constrictor vaginæ muscle, and is closely attached to additional bands derived from the levator ani.

Blood-vessels and Nerves.—The vascular and nervous supplies of the vagina are very generous. The *arteries* are derived from the vaginal, the internal pudic, the vesical, and the uterine branches of the internal iliac. Corresponding *veins* return the blood to a large extent, in addition to which the vaginal plexus surrounds the lower part of the canal and communicates freely with the neighboring vesical and hemorrhoidal plexuses. The urethral plexus around the upper portion of the urethral canal receives the dorsal veins of the clitoris. Within the submucosa large and plentiful venous radicles, together with bands of involuntary muscle, give this layer the character of erectile tissue.

The *lymphatics* of the vagina constitute two groups, those from the lower and the upper portions of the canal. The former join the lymphatics of the external genital organs and end within the superior or oblique set of inguinal glands; the latter, together with the vessels from the lower part of the uterine body and the cervix, proceed outward within the broad ligament, joining with the lymphatics from the oviduct and the ovaries, and terminate in the lumbar glands.

The *nerves* of the vagina are contributions from both the sympathetic and the cerebro-spinal system. The branches of the former are derived from the inferior hypogastric plexus, those of the latter from the fourth sacral and the pudic nerve. The sympathetic fibres are largely distributed to the vascular tissues.

3. **Internal Organs of Generation.**—*The Uterus.*—The *uterus,* the thickened and specialized segment of the generative tube for the reception, the retention, the development, and the final expulsion of the product of conception, in its mature but virgin condition is a slightly pyriform body whose thick, dense walls enclose a narrow, cleft-like cavity. The organ lies within the pelvis,

held by supporting peritoneal folds and muscular bands extending between the bladder in front, the rectum and the sacrum behind, and the pelvic walls at the sides; the most dependent portion of its lower and smaller segment, the *cervix*, projects within the upper part of the vagina.

The *virgin uterus* (Figs. 28, 29) measures about 7.5 centimeters (about 3 inches) in length, 4 centimeters (about $1\frac{1}{2}$ inches) in its greatest width, and

FIG. 28.—Anterior view of virgin uterus, showing relations of cervix to corpus uteri and reflection of peritoneum at isthmus.

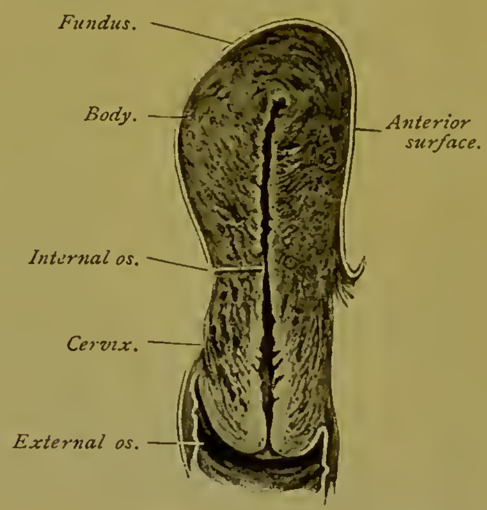


FIG. 29.—Sagittal section of virgin uterus, showing position of os internum, fusiform character of the cervical canal, and relations of the peritoneum.

about 2.5 centimeters (1 inch) in thickness; of the entire organ, approximately three-fifths belong to the body and two-fifths to the neck, the latter being relatively much longer in the nulliparous adult than after pregnancy has

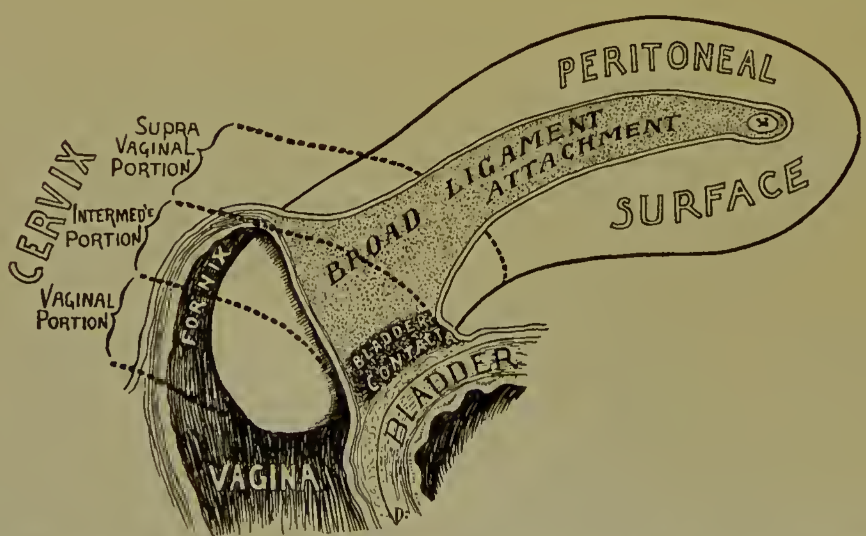


FIG. 30.—Diagram illustrating the relations of the uterus to the vagina, bladder, and peritoneum.

occurred. The division of the uterus into body and neck is indicated externally by the constricted *isthmus uteri*, which is situated about midway in the organ; internally, however, this boundary is uncertain, since the contours of the cervical mucous membrane gradually pass into those of the general uterine lining.

The pyriform *body* is almost flat on its anterior surface, but posteriorly is distinctly convex; its superior and anterior arched border is thick and rounded, and passes over into the slightly convex lateral borders at the superior angles. The upper part of the organ, including its superior arched border, constitutes the *fundus* and is completely invested with peritoneum. The serous covering of the anterior surface extends only as far as the isthmus, whence it is reflected to the neighboring vesical wall. The peritoneum on the posterior wall is complete, since the serous membrane is prolonged downward and backward about 2.5 centimeters beyond the cervix upon the posterior wall of the vagina before passing to the rectum. The lateral borders mark the attachment of the broad ligaments.

The *cervix*, slightly spindle-form in general outline, may be divided into three portions or zones (Fig. 30), the supravaginal, the intermediate, and the intravaginal. The first of these zones occupies the upper half of the cervix, extending somewhat farther forward along the anterior surface, where it comes in relation with the bladder, than posteriorly, where covered by the peritoneum of Douglas's pouch. The intermediate portion includes the zone of vaginal attachment, hence it is narrow and oblique, extending higher behind than in front. The intravaginal segment, or *os uteri*, projects within the vaginal canal in such manner that its axis is directed toward the posterior wall, and it

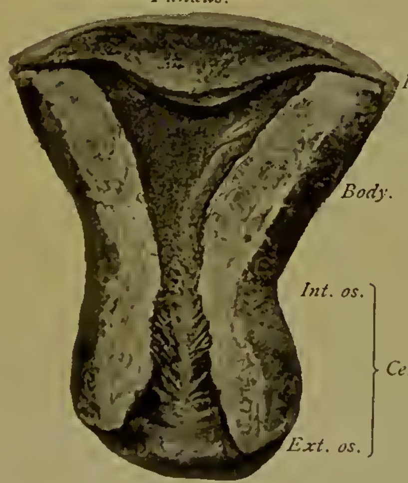


FIG. 31.—Cavity of uterus displayed by removal of anterior wall.

FIG. 32.—Virgin uterus laid open, showing the rugous condition of the cervix.

presents the transversely oval orifice of the cervical cavity, bounded by the rounded and prominent anterior and posterior lips or labia, the anterior of which is somewhat the thicker and shorter. The proportion between the body and the cervix varies with age: in the young virgin adult the uterus is about equally divided between these segments; in early life the cervix greatly preponderates over the imperfectly developed fundus; while after childbirth the fundus never returns to its former size, always remaining enlarged and nearly twice its original length (Fig. 31). With the advent of old age the entire organ suffers marked atrophy.

The *cavity of the virgin uterus* is very narrow, the apposition of the anterior and posterior walls of its body reducing the space to little more than a longitudinal cleft, as seen in mesial sagittal sections (Fig. 29). Viewed

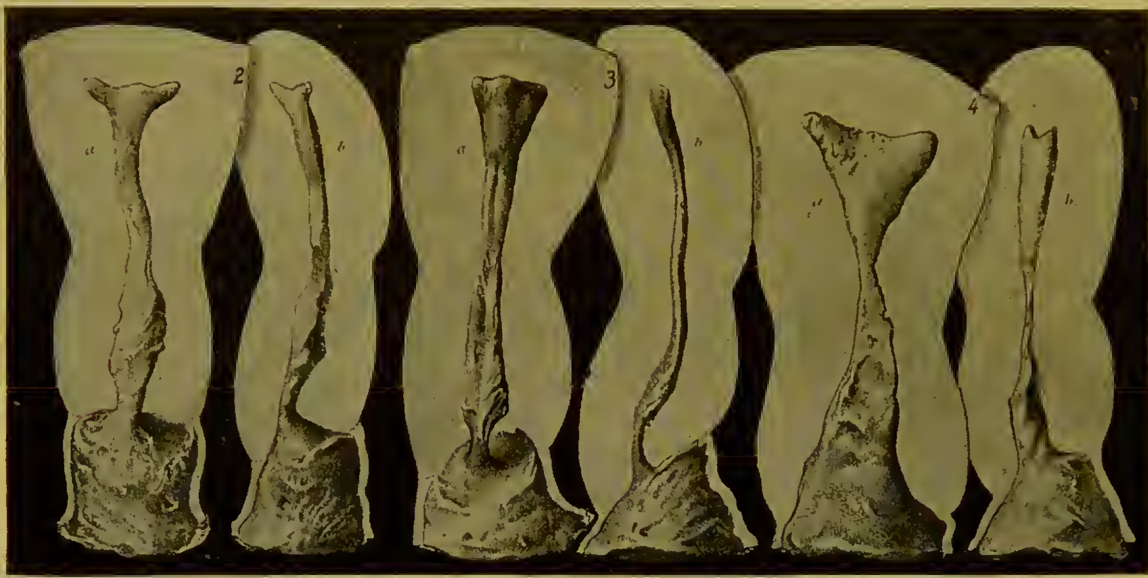


FIG. 33.—Casts of the cavities of uteri of various ages and conditions (modified from Hagemann): 2, 3, from nulliparæ of eighteen and twenty-four years; 4, from a woman of forty-eight years who had one child fifteen years previous.

from in front, the uterine cavity is triangular, the expanded base extending between the orifices of the oviducts, and the apex corresponding with the inner

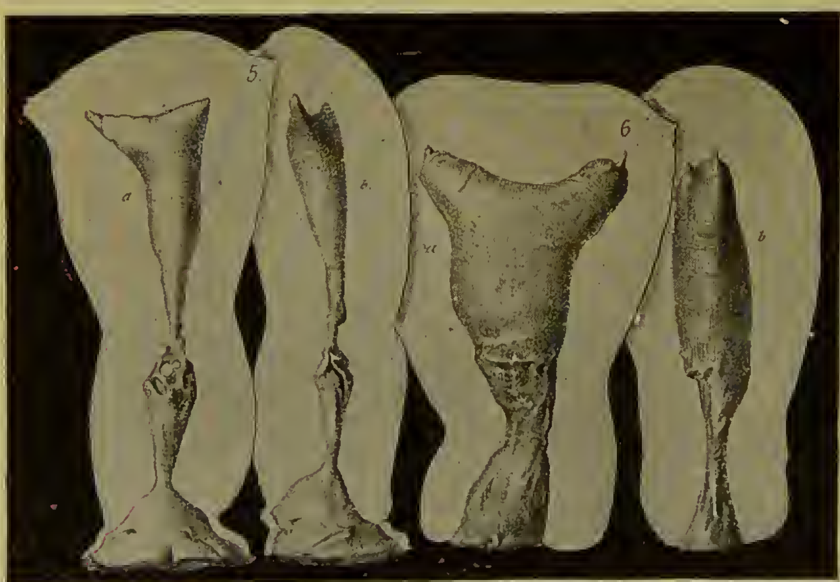


FIG. 34.—Casts of the cavities of uteri from (5) a nullipara of sixty-eight years, and (6) from a parous subject of seventy years (modified from Hagemann).

FIG. 35.—Front and profile views of casts of the uterine cavity of a new-born infant (modified from Hagemann).

opening of the cervical canal. On account of the encroachment of the uterine walls, the cavity of the uterus between the angles presents concave outlines.

The *cavity of the cervix* is fusiform, being of larger diameter at its middle than at the ends, the *os internum* and the *os externum*. The os internum, which marks the point of greatest contraction, possesses a lumen of circular outline; the os externum before pregnancy appears as a narrow, transversely placed orifice. The anterior and posterior walls of the virgin cervical canal exhibit conspicuous plications depending upon the arrangement of the bundles of muscular tissue; these rugæ are arranged as principal longitudinal folds, the anterior and posterior columns, from which secondary plications extend laterally. These corrugations collectively form the *arbor vitæ* (Fig. 35) of the uterus, being best marked in the virgin and being effaced by repeated parturitions.

Structure.—The uterine walls include a mucous, a muscular, and a serous coat. The *mucosa* consists of a tunica propria of delicate bundles of fibro-elastic tissues covered by an epithelium composed of a single layer of ciliated columnar cells. Numerous wavy tubular depressions, the *uterine glands* (Fig. 36), are also lined by the ciliated epithelium. Since a submucous layer is

FIG. 36.—Section of human uterus, including mucosa (*a*) and adjacent muscular tissue (*b*); *c*, epithelium of free surface and tubular uterine glands (*d*); *f*, deepest layer of mucosa, containing fundi of glands; *h*, strands of non-striped muscle penetrating within the mucosa (Piersol).

wanting, the blind and often forked extremities of these glands abut directly upon the muscular tissues.

The *cervical* mucosa differs from that of the body, being thicker and firmer, supplied with papillæ, and covered with stratified squamous epithelium within the lower third. In the upper half or two-thirds of the cervix the epithelium is ciliated columnar, similar to that of the body. In addition to the tubular follicles, the representatives of the usual uterine glands, numerous short, widely-expanded mucous crypts lie within the cervical mucosa. Retention of the secretion of some of these mucous sacs often takes place, the resulting greatly distended cysts appearing as translucent yellowish vesicles, the so-called *ovulæ Nabothi*. In its meagre supply of glands the mucous membrane of the lower part of the cervix still further resembles that of the adjacent vaginal surface.

The *muscular coat* (Fig. 37) of the uterus consists of bundles of unstriped muscle (Fig. 38) separated by bands of connective tissue and surrounding vascular channels. Although irregularly arranged, the muscular tissue is disposed in three general strata—an inner, a middle, and an outer layer. The inner layer,

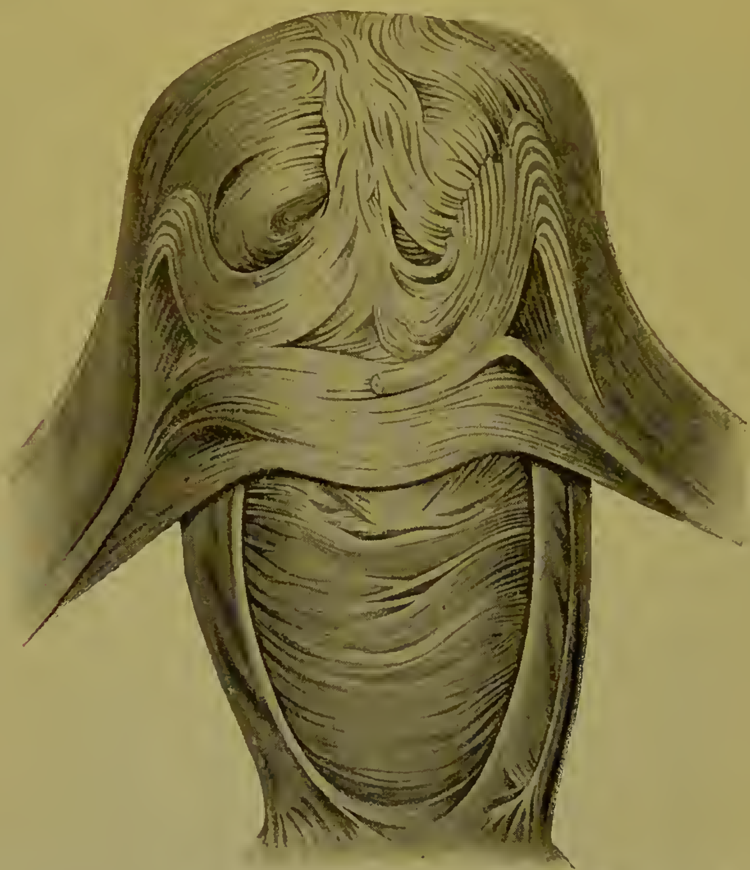


FIG. 37.—Arrangement of uterine musele, as seen from in front after removal of serous coat (Hélie).

composed principally of longitudinal bundles, is in direct contact with the mu-

FIG. 38.—A, isolated muscle-elements of the non-pregnant uterus; B, eells from the organ shortly after delivery (Sappey).

cosa, and is sometimes regarded as belonging to that layer, as being a hypertrophied muscularis mucosæ. The middle layer is most robust, and forms the greater part of the muscular coat, consisting chiefly of bundles having a general circular disposition. This layer is also distinguished by the numerous large venous channels enclosed between its bundles, hence the name, *stratum vasculare.* The outer layer includes both circular and longitudinal bundles, the latter predominating and lying in close relation with the superimposed serous coat. Many bundles of the outer layer pass into the broad ligaments; some of these enter the round ligaments and accompany the areolar tissue and the blood-vessels composing these structures toward the groin, while others extend along the oviducts and ovarian ligaments. Muscular bands pass also from the uterus into its supporting folds, the sacro-uterine band being particularly robust. The musculature of the cervix is distinguished by greater regularity in its arrange-

FIG. 39.—Broad ligaments viewed from the posterior surface, showing uterus, oviducts, and ovaries; the natural position of the latter has been disturbed in consequence of the separation of the supporting attachments.

ment, which includes a distinct inner longitudinal, a middle circular, and an outer longitudinal layer.

The *serous coat* of the uterus comprises the usual constituents of the peritoneum.

Ligaments.—The supporting apparatus of the uterus consists of two parts, the folds of peritoneum and the muscular bands which extend from the uterus to adjacent structures. The first group includes two anterior, two lateral, and two posterior ligaments; the second group, the so-called "muscular ligaments," is represented by the utero-inguinal, the utero-ovarian, the utero-pelvic, and the utero-sacral muscular bands; the last of these, the utero-sacral, are included within the posterior peritoneal folds; the remaining ones lie between the layers of the lateral or broad ligaments.

The *anterior ligaments* are two inconspicuous semilunar peritoneal folds which pass between the upper part of the cervix on each side to the adjacent posterior surface of the bladder, and bound the *vesico-uterine* pouch.

The *lateral* or *broad ligaments* (Fig. 39), as implied by their name, are two wide duplicatures of peritoneum that extend from the sides of the uterus and the vagina to be attached to the lateral wall and the floor of the pelvis. Each of these broad folds presents four borders, the superior, the inferior, the internal, and the external; of these but one, the superior, is free, the others being intimately joined with neighboring parts. The *superior* or *free border* encloses the oviduct, whose tortuous course it follows as far as the fimbriated end; at this point the plication diverges toward the pelvic wall and forms the *infundibulo-pelvic ligament*, which fold connects the end of the tube with the side of the pelvis and transmits the ovarian vessels. The *inferior border* is united with the recto-vesical fascia covering the levator ani, the subperitoneal tissue intervening between its diverging lamellæ giving transit to blood-vessels and nerves as well as to the ureter. The *internal border* is attached to the sides of the uterus and the vagina, the blood-vessels and muscular bands passing into the tissue of the broad ligament between its divergent layers. The external border comes in relation with the obturator fascia and affords transit for the uterine vessels and the round ligament.

The broad ligaments enclose within their serous folds structures of importance (Fig. 40). Along their unattached superior margins lie the oviducts; a

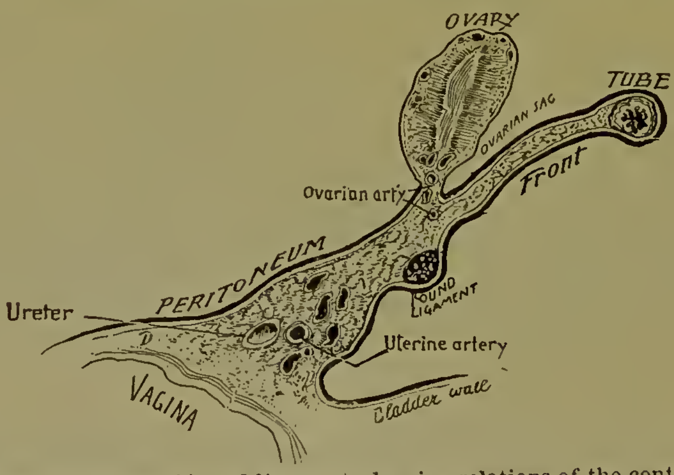


FIG. 40.—Diagrammatic section of broad ligament, showing relations of the contained structures.

little lower and anteriorly are situated the round ligaments; posteriorly, the ovaries and their muscular attachments; numerous blood-vessels, nerves, and lymphatics, together with the parovarium, the paroöphoron, and the utero-pelvic bundles of involuntary muscles which pass from the uterus and the vagina to the obturator fascia, are additional structures included within these folds.

The *round ligaments* (Fig. 41) are two flattened cord-like bands, from 10 to 12 centimeters in length, attached to the upper segment of the uterus in front of the oviducts, and extending from this point downward, outward, and forward, winding round the deep epigastric artery on the inner side of the external iliac artery, to the internal orifices of the inguinal canals, through which they pass to blend with the tissues of the labia majora. The round ligament possesses a covering of peritoneum, and in the young subject a funnel-like depression marks

FIG. 41.—Dissection of the pelvic organs, showing the relation of the abdominal parietes to the round ligaments and the bladder: 1, 3, the obliterated hypogastric arteries; 2, the urachus (Bourgery and Jacob).

a tubular extension of the peritoneal sac along the cord as it leaves the abdomen; this extension constitutes the *canal of Nuck,* and is homologous with the pro-

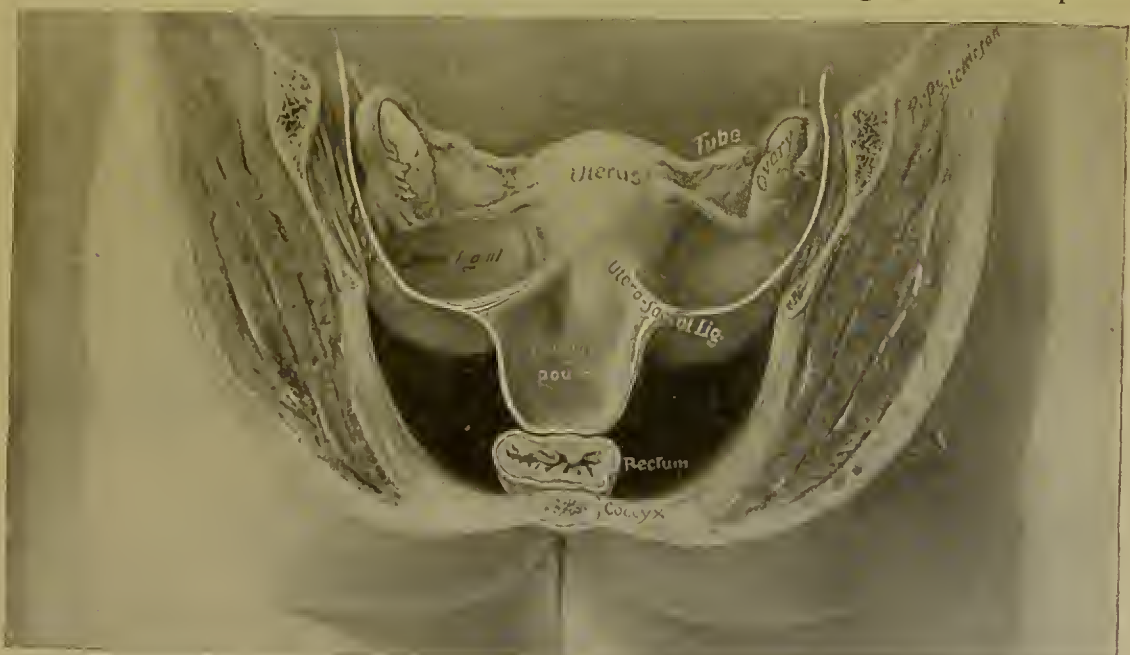


FIG. 42.—Posterior view of the uterus and ovaries, with the peritoneal folds composing the broad ligaments and the utero-rectal fossa (modified from Hodge).

cessus vaginalis of the male. It is usually obliterated after early life, but may persist, and, in rare cases, be accompanied by an abnormally descended ovary, which then occupies a position within the labia, behind the peritoneal sac. In structure the round ligament consists of bundles of connective tissue and blood-vessels, together with plain muscular tissue derived from the uterus.

The *posterior* or *recto-uterine ligaments* are two peritoneal folds which pass backward from the cervix and the upper part of the vagina to become continuous with the serous covering of the second portion of the rectum. The deep fossa included between these folds laterally, the uterus anteriorly, and the rectum posteriorly constitutes the *pouch of Douglas* (Fig. 42), which is frequently occupied by coils of small intestine. Between the layers of the posterior ligaments flat bands of involuntary muscular tissue, the so-called *utero-sacral*

FIG. 43.—Sagittal section of female pelvis, showing the utero-sacral ligaments suspending the uterus, also the pubic segment part of the supporting apparatus of the uterus (Dickinson).

ligaments (Fig. 43), extend on each side from the highest segment of the cervix to the sides of the sacrum, at the level of the sacro-iliac juncture. These bands, among the most important parts of the supporting apparatus of the uterus, are intimately related with the muscular coat of the rectum, which tube they encircle near the union of its first and second parts; laterally and anteriorly they are in close relation with the pouch of Douglas.

The *position* of the normal uterus (Fig. 22) during life has received consideration from many investigators, whose conclusions, however, have been so contradictory and uncertain that almost every situation of the organ has in turn been regarded as representing its normal relation. This discrepancy has been due in large measure to the methods of examination employed, which include observations on the cadaver, bimanual examination of the pelvic organs of the living subject, and frozen sections of the parts shortly after death.

The examination of the viscera in the cadaver in the usual way, even when carried out with skill and precaution, must necessarily be untrustworthy as to the details of topographical relations, on account of the uncertainty introduced by reason of the unavoidable post-mortem alterations and inevitable distortions affecting the organs. The apparent exactness of the method of frozen sections likewise is unfavorably influenced by the relaxation after death of the supporting bands which during life maintain the positions of the organs; it follows, therefore, that the testimony of sections cannot be accepted as unimpeachable evidence as to relations during life, since the relations preserved are only those existing at the time of fixation; likewise, the possibility of encountering the effects of pathological changes in frozen sections must also be appreciated. The testimony of the most competent and careful investigators points to the conclusion that the most valuable and trustworthy observations as to the normal position of the uterus are to be gathered from careful examinations of properly preserved bodies, where the organs have been hardened in situ *immediately* after death. The results of such investigations closely agree with the opinions of the most expert observers derived from repeated examinations on the living subject.

Fig. 44.—Diagrams illustrating range of variation in position of uterus as affected by distention of the bladder (Van de Warker).

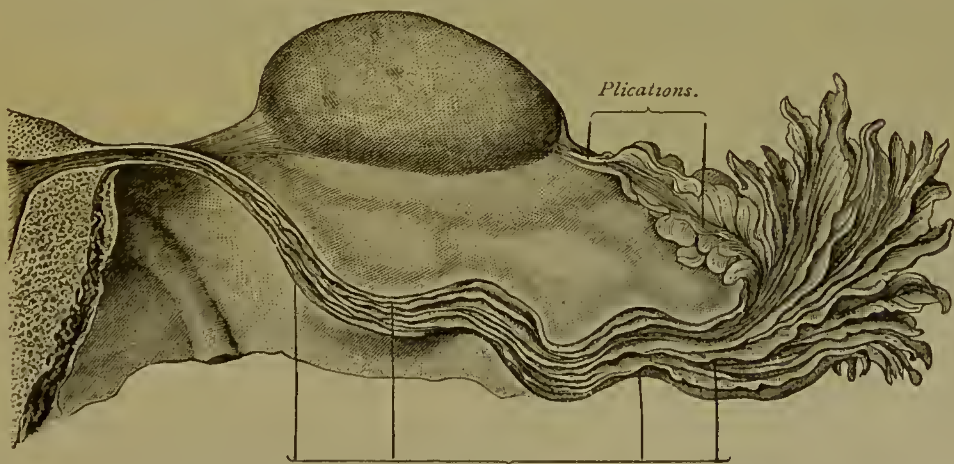


Fig. 45.—Longitudinal section of Fallopian tube, exposing the complicated longitudinal plications of the mucosa which expand into the fimbriæ (Sappey).

In accordance with the conclusions based on such grounds, the normal uterus most probably occupies a position almost horizontal in the upright posture: the fundus, usually slightly to one side of the mid-line, rests on the bladder and is directed forward and upward, while the cervix forms a slight deflection with the axis of the uterine body and looks down and backward against the posterior vaginal wall. Whether the uterus lies most frequently to the right or to the left of the mid-line is still in dispute; the latter position, to the right, is probably most usually encountered (His), although the opposite condition, as shown on Plate 8, is certainly not uncommon. The topographical relations between the uterus and the bladder are so close that the position of the womb is materially influenced by vesical distention. The range of variation in the position of the normal uterus is diagrammatically represented by Figure 44.

The *oviducts*, or *Fallopian tubes* (Fig. 38), the representatives of the ununited portions of the fetal Müllerian ducts, extend from the superior rounded angles of the uterus, within and along the free upper margin of the broad ligaments for a distance of from 10 to 12 centimeters, to the vicinity of the ovaries, where each terminates in an expanded funnel-shaped orifice, the pavilion or *infundibulum*, surrounded by a series of fringed processes, the *fimbriæ* (Fig. 45). Examined in carefully-preserved specimens retaining the typical position of parts, the tube at first passes outward closely related with the pelvic floor; it then turns upward along the attached anterior border of the ovary, when, after reaching the upper pole of the gland, the tube bends downward upon the free posterior border and the inner surface of the ovary (Figs. 22, 41), which are by this means partly masked (Waldeyer).

The oviduct commences at the inner attached extremity as a narrow tube, the *isthmus*, about 2 millimeters in diameter; during its further slightly wavy course it gradually gains in width until the tube measures 4 millimeters or more, when it again becomes somewhat narrowed, but beyond the ovary it rapidly expands into the ampullæ and the fimbriated extremity (Fig. 46). The lumen of the tube is narrowest at its inner end, where it opens into the cavity of the uterus by a minute orifice, the *ostium internum*, which scarcely admits a bristle; the diameter of the canal gradually increases until it presents, just before its final expansion into the fimbriated orifice, a distinct opening, the *ostium abdominale* (from 4 to 6 millimeters in width), situated at the bottom of the cleft-like depression leading from the attached border of the fimbriated expansion.

FIG. 46.—Portion of broad ligament stretched to show the parovarium (P) lying between the folds and consisting of the head-tube and cross-tubules (Gegenbaur).

Structure.—The oviduct consists of three coats—an inner mucous, a middle muscular, and an outer serous. The *mucous* lining presents numerous longitudinal folds (Fig. 47); these become more conspicuous within the infundibulum, where they greatly increase in size and complexity and terminate in the sinuous border of the fimbriæ. All parts of the canal, including its expanded outer end, are clothed by a single layer of ciliated columnar cells, whose ciliary current sweeps from the fimbriæ toward the uterine end of the tube. At the free edge of the fimbriæ the columnar epithelial cells give place to the low, plate-like elements of the peritoneum covering the exterior of the tube. Glands are absent within the mucous membrane of the oviduct. The *muscular tunic* includes a principal inner layer of circularly-disposed bundles of involuntary muscle and a slightly-developed outer layer of longitudinal bundles. The

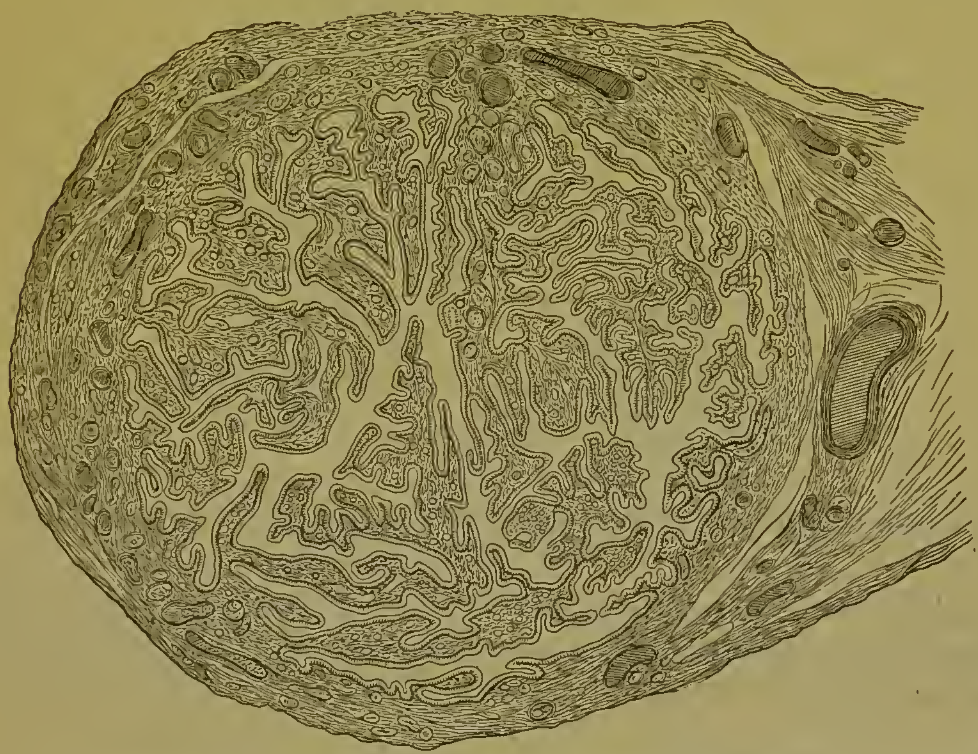


FIG. 47.—Transverse section of Fallopian tube, showing the complicated arrangement of the longitudinal plications which are here cut across (Martin).

serous coat consists of the fibro-elastic stroma and endothelium of the general peritoneal investment contributed by the broad ligament.

The *blood-vessels* of the oviducts are branches from the ovarian and the uterine arteries and the corresponding veins, the arteries possessing an unusually tortuous course. The *nerves* are derived from the ovarian and uterine plexuses, and consist of both medullated and pale fibres.

The Ovaries. — Each ovary presents a flattened ovoid mass, somewhat almond-shaped, which appears as an appendage of the posterior surface of the broad ligament (Fig. 39), to which the organ is attached by its straighter anterior border. The dimensions vary with the individual as well as with the condition of functional activity; the longest diameter usually measures about 3.5 centimeters, the width about 2 centimeters, and the thickness a little over 1 centimeter. The weight of the ovary is ordinarily between 6 and 7 grams, the right being commonly slightly heavier and larger than the left ovary.

The anterior border alone is attached; the arched posterior border and the broad surfaces are free and are covered with modified peritoneum, the *germinal* *epithelium*, directly continuous with the serous covering of the broad ligament. The position of the ovaries *in situ* (Pl. 8; Figs. 22, 41) and during life, at least before the permanent displacement attending pregnancy has taken place,

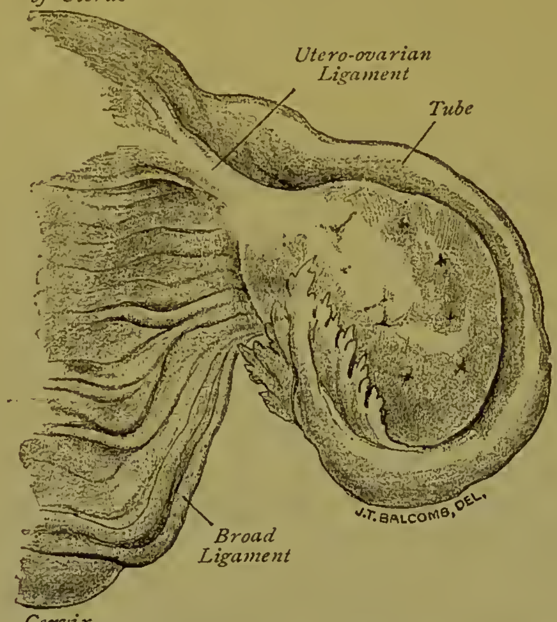


Fig. 48.—Ovary (natural size), with the Fallopian tube in relative position. Specially drawn from nature for this Text-book. (Original.)

is probably such that the long axes of the organs are nearly vertical (Waldeyer, His, Cunningham) and correspond closely with the sagittal plane, so that the broader surfaces may be spoken of as internal and external rather

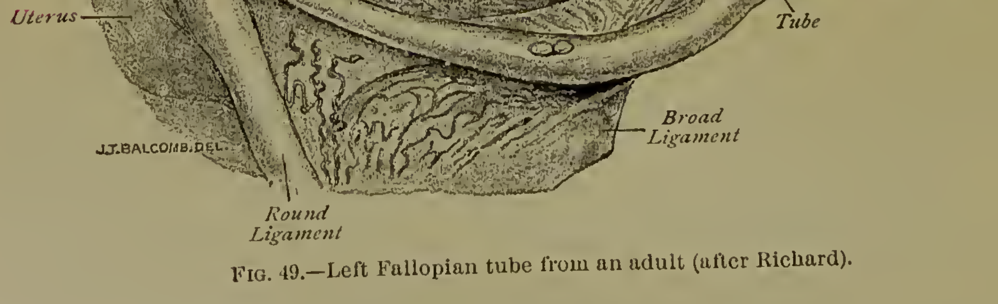


Fig. 49.—Left Fallopian tube from an adult (after Richard).

than as anterior and posterior. The position of the fundus uteri is a factor of moment in determining the ovarian axis, since, as pointed out by His, the pull of the uterus when not occupying a mesial position predisposes to increased obliquity of the ovarian axis of the opposite side.

The smaller and lower end of the ovary, or the *uterine pole*, points toward the uterus, with which it is united by means of the fibro-muscular bands constituting the *ovarian ligament;* the upper and blunter end, or the *tubal pole*, after being embraced by the arching oviduct, receives the lower border of the fimbriated extremity of the Fallopian tube, and is further connected to the wall of the pelvis by the *ovario-pelvic fold* of the peritoneum. The ovary lies within a peritoneal recess, the *fossa ovarii* (Claudius), which occupies the posterior part of the side wall of the pelvis, usually bounded by the internal iliac artery and the ureter behind and the obturator vessels and nerve in front. Both the anterior and posterior borders of the gland, as well as its inner surface, are closely related to and are partly masked by the curves of the oviduct.

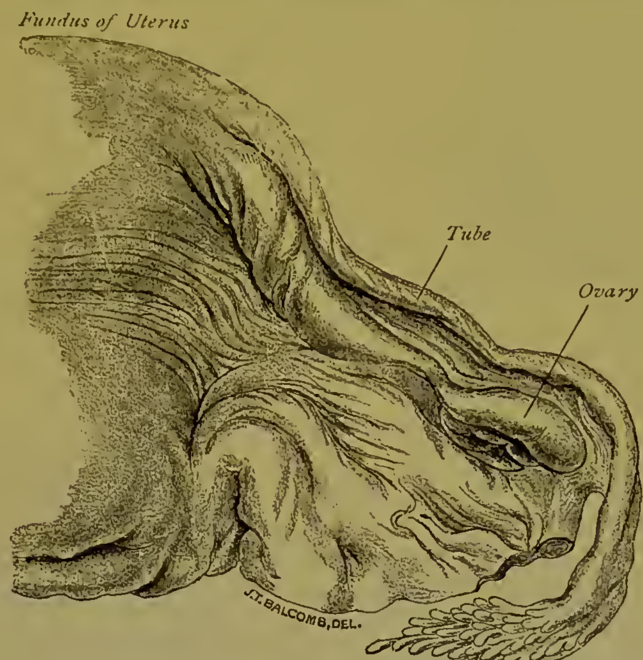


FIG. 50.—Ovary and tube (natural size) of a woman of sixty-eight years. Specially drawn from nature for this Text-book. (Original.)

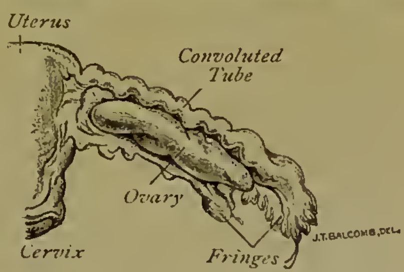


FIG. 51.—Uterus, tube of a child one month old. Specially drawn from nature for this Text-book. (Original.)

Structure.—The ovary is divided into the *cortex* and the *medulla* (Fig. 52), the boundaries of which are conventional and not sharply defined. The *cortex* includes the peripheral zone, containing the Graafian follicles and the ova, and occupies approximately the outer third of the organ. The *medulla* embraces the remaining central portions of the organ, in which the blood-vessels, entering through the hilum, are conspicuous.

The bulk of the organ consists of the *ovarian stroma*, a peculiar form of connective tissue in which lie imbedded the Graafian follicles, distinguished by the great number of its spindle-cells. These cells are especially closely packed in the cortex immediately beneath the surface covered by the germinal epithelium, in which situation they constitute a layer of greater density than the adjacent stroma, to which the name *tunica albuginea* is applied; this stratum, however, is only a condensation of the ordinary stroma tissue, and is not an independent envelope.

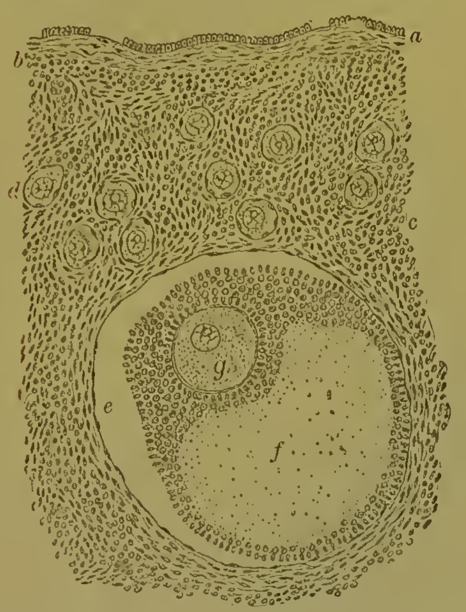


Fig. 52.—Section of human ovary, including cortex: *a*, germinal epithelium of free surface; *b*, tunica albuginea; *c*, peripheral stroma containing immature Graafian follicles (*d*); *e*, well-advanced follicle from whose wall membrana granulosa has partially separated; *f*, cavity of liquor folliculi; *g*, ovum surrounded by cell-mass constituting discus proligerus (Piersol).

The Graafian follicles, the most important constituents of the cortex, are exclusively limited to this part of the ovary, where they occur in all stages of development. The least mature follicles consist of ova surrounded by a single layer of flattened cells, the progenitors of the membrana granulosa. Among the immature follicles are others in

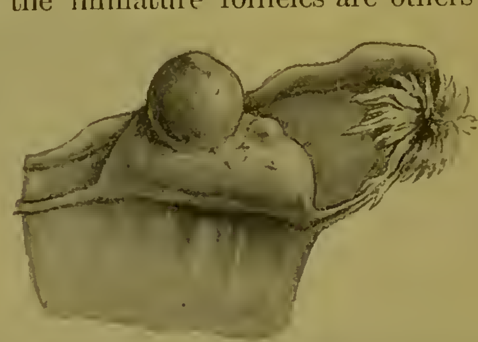


Fig. 53.—Ovary with mature Graafian follicle about ready to burst (Ribemont-Dessaignes).

various stages of more advanced development, where the ova are encircled by two or more rows of polygonal cells which by their division give rise to the numerous elements lining the follicle.

Both the ova and the surrounding cells are derivatives of the *germinal epithelium* covering the free surface of the ovary, from which they dip into the stroma as cylindrical cell-cords. With the increase in size which accompanies their development the Graafian follicles pass toward the inner limits of the cortex bordering on the medulla, where they undergo further enlargement; after a time their diameter includes almost the entire cortex, and extends from the medulla to the surface of the ovary, the position of the follicle becoming evident on the free surface as a distinct projection (Fig. 53), marking the point at which the final rupture of the sac and the escape of the ovum take place.

The mature Graafian follicles appear as clear, slightly elongated vesicles 8 to 12 millimeters in diameter; they are defined from the surrounding tissue by a condensed layer of the ovarian stroma, the *theca folliculi*. Within the theca follows the *membrana granulosa*, consisting of many layers of small polyhedral epithelial cells. At one point the membrana granulosa presents a thickening which encloses the ovum and constitutes the *discus proligerus*. The cells of the discus next the ovum lie vertical to its surface, forming a radial zone, the *corona radiata*. Within this layer lies the sexual cell, the ovum, which will be considered more fully in the section relating to its development.

The formation of new follicles continues only for a short time after birth;

ovisacs are then most numerous, the entire number contained within the two ovaries of the child being estimated at over seventy thousand. In view of the unquestionably large number of follicles in very young ovaries, and the relatively small proportion of ova which reach maturity, the degeneration of many follicles after attaining a certain development seems certain. The atrophic remains of such degenerating Graafian follicles continually encountered point conclusively to the fate of a large contingent.

The *medulla* contrasts with the cortex by its looser structure and the number and size of its vascular, and particularly its venous, canals. A considerable amount of involuntary muscle is intermingled throughout the fibrous tissue separating the blood-vessels. Irregular groups of polyhedral cells are encountered between the fibrous bundles of the medulla; these elements, the *interstitial cells,* represent the remains of atrophic parts of the fetal Wolffian bodies.

On the escape of the ovum, surrounded by the cells of the discus proligerus, the ruptured and partly collapsed follicle becomes filled with blood poured out from the torn vessels of the walls of the follicle. Subsequent changes lead to the conversion of the follicle into a *corpus luteum.* This characteristic structure is formed by the ingrowth and rapid proliferation of the vascular tissue of the follicular wall, spindle-shaped connective-tissue cells and large cells containing yellow pigment, *lutein,* being the most active elements in the process. The history of the corpus luteum is materially affected by the occurrence of pregnancy, since, instead of being almost entirely absorbed within a few weeks, as is the rule with the ordinary bodies, when fertilization takes place they persist until after the end of gestation. It is usual, therefore, to distinguish the *corpus luteum of pregnancy,* or the *corpus verum,* from the *corpus luteum of menstruation.* The mode of growth is identical in both, the stimulus of impregnation leading usually to excessive development. The primary blood-clot occupying the ruptured follicle becomes invaded by the enlarged and thickened wall, which soon becomes corrugated, the plications encroaching upon the clot and increasing to such an extent that the folds crowd against one another and eventually form an irregular broad envelope surrounding the remains of the central clot. When pregnancy occurs the processes are continued beyond their usual length, resulting by the end of the first month in the production of a mass from 12 to 20 millimeters in diameter, characterized by a brilliant yellow peripheral zone surrounding a lighter centre. This condition is succeeded by the gradual reduction and cicatrization of the central area and the lighter tint of the now greatly corrugated broad outer belt. By the end of gestation the white nucleus constitutes about one-third of the entire corpus luteum, which has already become somewhat smaller (10 to 13 millimeters) than at the sixth month. After delivery absorption progresses rapidly, but for some months later the position of the corpus is distinguishable. The characteristic yellow color of these bodies is due to the presence of a peculiar pigment, *lutein,* and not merely to disintegrated blood.

The peculiarities distinguishing the corpus luteum of pregnancy from that of menstruation have long been regarded as of especial significance as supplying positive evidence that pregnancy has taken place. While the presence of the typical yellow body must be regarded as strongly indicative of such condition, the occasional encounter in the ovaries of undoubted virgins of corpora lutea possessing the characteristics of those of pregnancy, as recorded by

FIG. 54.—Ovaries of two virgins, showing large corpora lutea, resembling those of pregnancy (Hirst).

Hirst (Fig. 54), should lead to some reservation and to a demand for corroborative evidence in the acceptance of these bodies as infallible signs of the existence of pregnancy.

The Parovarium.—The *parovarium*, the *epoöphoron*, or the *organ of Rosenmüller*, consists of a group of inconspicuous tubular structures within the broad ligament, between the oviduct and the ovary, not far from the attached border of the latter organ (Fig. 46). The parovarium consists of a series of from twelve to eighteen short *tubules* which lie irregularly parallel, their ovarian ends slightly converging, and which are connected at their opposite extremities with the longitudinal *head-tube* of larger diameter extending for some distance within the broad ligament toward the uterus. The tubules are lined with low columnar epithelial cells, the representatives of the elements clothing the embryonic canals.

The parovarium represents the partially obliterated remains of portions of the Wolffian body of the fetus; the short canals correspond with the tubules of the body, while the head-tube is identical with the upper part of the Wolffian duct. When this latter canal persists throughout the greater part of its original extent, it constitutes *Gärtner's duct*, the homologue of the vas deferens; the entire parovarium corresponds morphologically with the tubules constituting the globus major of the epididymis.

Additional fetal remains in the form of rudimentary tubules are sometimes encountered within the broad ligament in the vicinity of the ovary, although situated rather nearer the uterus than the parovarium. These structures constitute the *paroöphoron*, and represent the atrophic transverse tubules of the lower part of the Wolffian body, being homologous with the paradidymis of the male. The closed tubules of the paroöphoron are lined with low columnar epithelium and are often occluded by partially shed cells. The tubules of these atrophic organs possess a practical interest from their liability to become diseased and converted into cysts which may assume large diameters.

The *stalked hydatid* of Morgagni frequently forms a conspicuous appendage to the broad ligament near the fimbriated extremity of the oviduct (Fig. 55). This pedunculated vesicle, which varies greatly in size, represents the remains of the pronephros, being common to both sexes. Low columnar or cuboidal epithelium forms the lining of its dilated sac and stalk so far as pervious.

FIG. 55.—Stalked hydatid attached to fimbriated extremity of Fallopian tube (New York Hospital Cabinet).

The Vessels and Nerves of the Internal Generative Organs.—The vascular and nervous supplies of the uterus and its appendages and of the ovaries are so intimately related that they may conveniently be considered together. These organs receive their blood from three sources—the uterine, the ovarian, and the funicular arteries (Pl. 7).

The *uterine artery* is given off from the internal iliac close to the pelvic wall, along which it runs as far as the broad ligament, within whose folds it then passes, in front of the ureter, toward the cervix uteri. After giving off twigs which surround this part of the uterus the artery ascends along the body of the uterus, sending off branches which anastomose with those from the opposite side to encircle the organ. The upper terminations of the uterine freely communicate with the branches of the ovarian and the funicular arteries.

The *ovarian artery*, the homologue of the spermatic, is a branch from the abdominal aorta, and gains entrance through the infundibulo-pelvic band into the broad ligament, within which it divides into its two principal branches—the *tubal* and the *ovarian*. The tubal branch extends along the border of the oviduct, sending numerous twigs for the nutrition of the tube and the tissue of the broad ligament. The *ovarian proper* is of larger size, and passes close to the free border of the ovary, which it particularly supplies, finally anastomosing with the uterine and funicular arteries near the upper angle of the uterus.

The *funicular artery* is given off from the vesical, after which it joins the round ligament at the internal abdominal ring and divides into ascending and descending branches, the latter passing into the labium along with the ligament, there to anastomose with the external pudic; the former ascends backward within the ligament as far as the angle of the uterus, where it joins the ovarian and the uterine arteries.

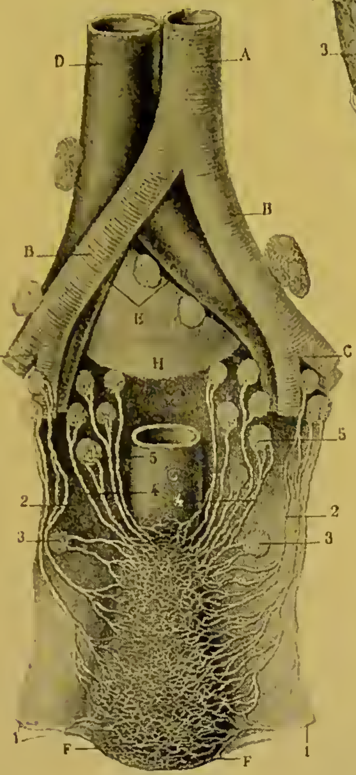
The *veins* of the uterus and of the ovaries are large and numerous and tend to form plexiform networks. Those of the *uterus*, always large, but of enormous size during pregnancy, form a plexus within the broad ligament, which plexus subsequently gives place to a trunk which accompanies the artery and terminates in the internal iliac vein. The *ovarian veins* are particularly well developed in the vicinity of the hilum; within the broad

EXPLANATION OF PLATE 9.

FIG. 1.—Lymphatics of the uterus, which has been turned forward (Sappey): A, aorta; B, common iliacs; C, bifurcation into iuterual and external iliacs; D, vena cava inferior; E, common iliac veins; F, uterus toppled forward; G, rectum; H, ligament unitiug sacrum with fifth lumbar vertebra; 1, lymphatic vessels passing under ovarics to follow the course of ovarian vessels; 2, lymphatics from body of uterus, which end in lymph-glands accompanying the iliac vessels; 3, lymph-glauds receiving the lymph-vessels of mucous membrane of cavity of body; 4, 4, lymphatics from lower portiou of surface of uterus, going to the glands behind internal iliac vessels, which glands (5) vary in uumber and volume.

FIG. 2.—Lymphatics of the pelvic viscera and the abdomen (Sappey): B, common iliacs; C, external and internal iliacs; D, vena cava inferior; G, common iliac veius; H, ureters; I, rectum; K, uterus; L, cervix; M, M, section of vagiua; N, N, Fallopian tubes; O, O, ovaries; Q, Q, round ligament; 2, superficial renal lymphatics; 3, converging trunks of same, emptying into lymph-glands (4); 7, 7, lymphatic plexus of the ovaries; 8, 9, trunks receiving ovarian plexus following course of utero-ovariau veins; 10, 11, glands receiving the lymphatics from ovaries; 12, lymphatics from fundus, joining ovarian plexus, with same terminations; 14, glands receiving (13) trunks from surfaces and borders of body of uterus; 15, lymphatics originating in lower part of cervix, mucous membrane of uterine cavity and vaginal fornices; 16, lymph-glands occurring along the course of these vessels; 17, efferent vessels of these glands takiug their course to the glands beneath external iliac vessels; 18, lymphatics which proceed from the posterior surface of the cervix, termiuating in the glands accompanying the internal iliac; 19, exceptional lymph-trunk from cervix passing to gland in front of fifth lumbar vertebra; 20, another exceptional lymph-gland and vessel situated along the course of the common iliac.

FIG. 3.—Lymphatics of the breast (Sappey): A, cellulo-adipose cushion supporting mammary gland; B, contour of mammary gland; C, superficial blood-vessels; 1, network of superficial lymphatics; 2, network of lymphatics originating in and draining the lobules of the gland; 3, large lymphatic trunks originating in the peripheral network; 4, plexus of lymphatics having their origin in the deeper parts of the gland; 5, large vessels originating in the iuuer part of this plexus; 6, 7, 8, large lymphatic trunks.



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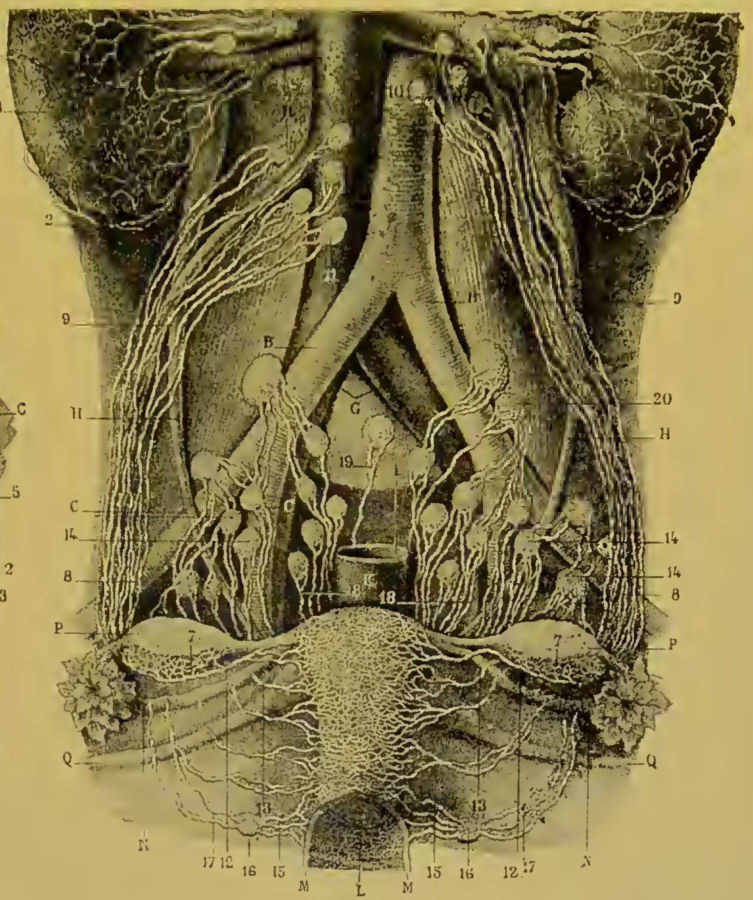

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1. Lymphatics of the uterus, which has been turned forward (Sappey). 2. Lymphatics of the pelvic viscera and abdomen (Sappey). 3. Lymphatics of the breast (Sappey).

cervix and adjacent part of the vagina, which extend along the base of the broad ligament and terminate within the internal iliac glands of the pelvis near the iliac artery at its point of division; 3. Those which accompany the round ligament and empty into the inguinal glands. These latter, as in the male, include two groups, those lying along the course of Poupart's ligament, which constitute the *oblique* set and receive the lymphatics from the genitalia, and those arranged about the saphenous opening as the *vertical* set, into which empty the superficial lymphatics of the lower limb. The great abundance of the lymphatics of the uterus, the cervix, and the vagina is a matter of much practical importance, since these channels furnish the paths by which septic matters may invade and affect parts widely removed from the focus of infection.

The *nerves* (Fig. 56) of the uterus, the ovary, and the oviduct are derived partly from the sacral nerves, particularly the third and the fourth, and partly from the sympathetic system as represented by the hypogastric and ovarian plexuses. The nerves include, therefore, both medullated and pale fibres, the latter being especially destined for the blood-vessels and the masses of involuntary muscular tissue.

The Mammæ.—The mammary glands, being really but highly specialized and greatly developed sebaceous follicles, belong to the integument, and, strictly regarded, have no place among the sexual organs. The closely associated functional relation of these organs in furnishing the nutriment for the newly-born animal, however, as well as convenience, has made it customary to describe them in connection with the organs of generation. The present purpose will require the consideration of the glands as developed in the female alone, the rudimentary organs of the male being disregarded.

The mammary glands of the human female (Fig. 57), as seen in well-developed women prior to pregnancy, protected by the integument and the fasciæ and the associated masses of adipose tissue, collectively form a pair of hemispherical prominences, the breasts, surmounted by the conical *mammillæ* or nipples.

The breasts as a whole are not quite circular in outline, since their attached bases present slight extensions inward over the sternum as well as outward, above and below, toward the axilla. Neither is the gland always limited by the deep fascia, since small aggregations of the glandular tissue may pierce the fascial septum and lie upon or become imbedded within the pectoral muscle—a matter of much practical moment in amputations of the mamma for malignant disease.

The size of the breasts depends so evidently upon the functional condition of the glandular tissue and the quantity and tonicity of the surrounding adipose tissue and other protecting structures that the dimensions of the organs must include a wide latitude of variation. The breasts may be said ordinarily to extend from the third to the seventh rib and from the sternal border to the anterior axillary margin, with a prominence depending much upon the amount of fat or upon the condition of the gland. The nipple is usually situated on a line corresponding with the level of the fourth rib, being directed somewhat outward and upward.

Varying with the general complexion, the nipple is of a roseate or a pinkish-brown tint, and is surrounded at its base by the *areola,* an area of modified integument about an inch in diameter, possessing the same color as the nipple. The changes in the appearance of this zone induced by pregnancy are more or less permanent, the deeply pigmented areola of the dark brunette never re-

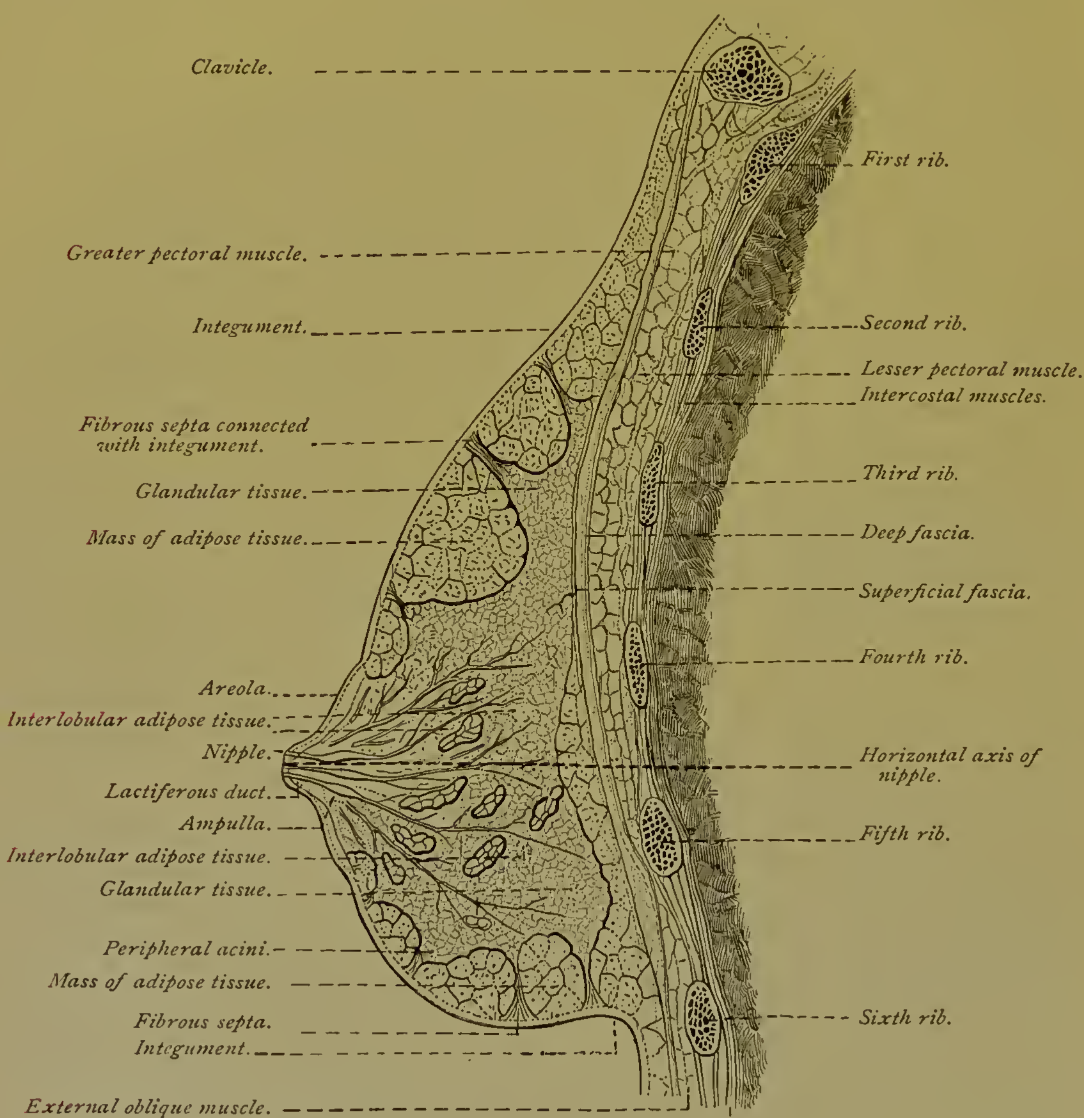


FIG. 57.—Longitudinal section of mammary gland *in situ;* frozen subject of twenty years (Testut).

gaining its former tint; in light blondes the darkening of the areola accompanying pregnancy is often very slight, and may subsequently almost entirely disappear.

The skin covering the areola is characterized by its variable pigmentation, by its delicacy, by the absence of subcutaneous adipose tissue, and by the presence of large sebaceous follicles, and, in addition to well-developed sweat-glands, small groups of glandular acini, the *accessory milk-glands,* of which from five to twelve are usually present. The sebaceous follicles during pregnancy become greatly increased in size and form prominent elevations, the *glands of Montgomery.* In addition to independent ducts opening on the surface of the areola, the accessory glands sometimes are connected with the milk-tubes traversing the nipple.

Both the nipple and the areola contain numerous bundles of unstriped muscular tissue, arranged as circular and radiating fibres, which respond to mechanical stimulation. The contraction of the circularly disposed fibres causes the nipple to become more prominent or "erected;" the radial fibres, on the contrary, tend to depress or retract the nipple.

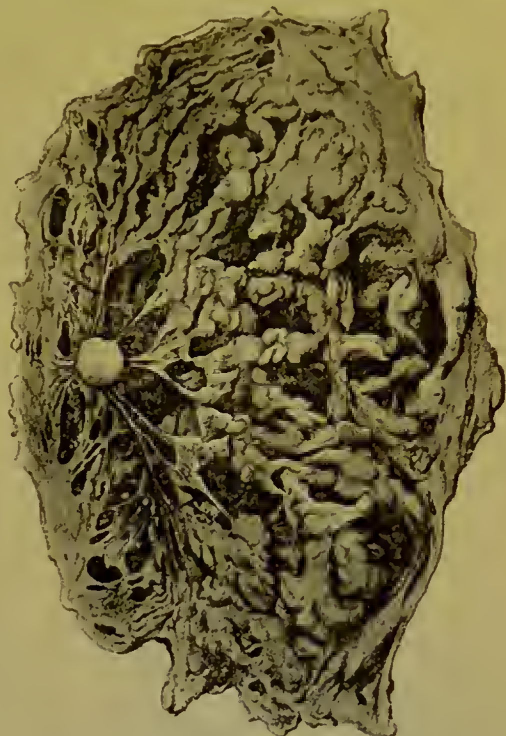


FIG. 58.—Arrangement of glandular tissue of breast, the fat having been removed to show the ducts and acini (Astley Cooper).

The secreting tissue of the mamma consists of an aggregation of pyramidal masses (from fifteen to twenty in number) of acini and ducts which correspond with the lobes composing the organ (Fig. 58). Each lobe represents a single highly developed and specialized sebaceous gland, whose excretory tube is the *lactiferous* or *galactophorous duct,* and whose secretory portion is the associated group of acini.

The individual component glands, the lobes, are invested by the surrounding connective tissue which constitutes the general supporting framework of the organ and the septa. The latter penetrate within the aggregations of acini and subdivide the lobes into lobules.

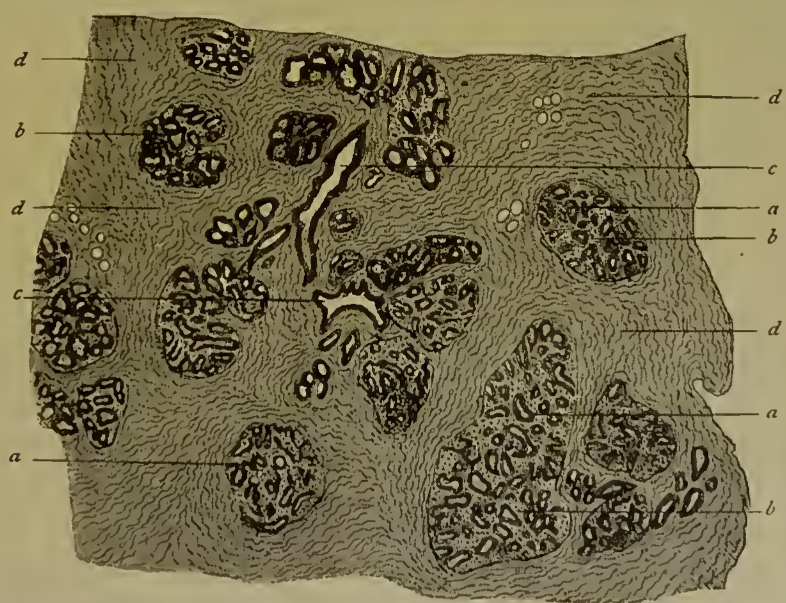


FIG. 59.—Section of mammary gland during lactation (Sinéty): *a*, *a*, lobules of secreting tissue, consisting of acini (*b*, *b*) lined with active epithelium; *c*, *c*, sections of excretory ducts; *d*, *d*, interlobular connective tissue.

Before the occurrence of pregnancy and of the functional activity associated with lactation the secreting tissue forms but an insignificant portion of the entire volume of the mamma (Fig. 59), but during lactation the acini become enormously developed, the lobules of true glandular tissue being readily discovered as nodular masses within the more yielding areolar adipose envelope. Under the stimulus of the unusual demands made upon the organ under such conditions, it is probable that new glandular tissue is formed as extensions of the existing acini.

FIG. 60.—Dissection of breast, showing suspensory ligaments and milk-ducts (Astley Cooper).

The acini of the fully developed but non-functionating organ are lined by a single layer of short columnar or polyhedral epithelial cells, the protoplasm of which appears granular. The cells rest upon a delicate membrana propria which envelopes the acinus and which is continued on to the minute excretory ducts with which the acini are connected.

These passages, lined with a modification of the glandular epithelium, join with others to form larger tubes, which in turn take part in forming the interlobular canals. These canals are superseded by the wider excretory tubes draining the entire lobe, which, directly or after joining other tubes, become the converging lactiferous or galactophorous ducts.

The lactiferous ducts (Fig. 60) on reaching the areola undergo dilatation and form the *ampullæ* or *milk-sinuses*. These ampullæ lie beneath the areola, and during lactation attain each a diameter of from 4 to 6 millimeters, constituting important reservoirs for the milk secreted during the periods intervening between the evacuations of the gland. At the base of the nipple these ducts undergo a reduction in size and become closely collected, the larger tubes occupying the centre of the group; surrounded by areolar and muscular tissues, they ascend to the summit of the mammilla as independent tubes, where they terminate by distinct orifices which open into minute depressions occupying the apex of the nipple.

The epithelium lining the ampullæ and the lactiferous ducts is of the low columnar or cuboidal variety; within a short distance of the termination of the ducts upon the nipple, the lining of the tubes changes its character to correspond with that of the adjoining epidermis, becoming stratified squamous.

The changes taking place within the lining cells of the acini on the establishment of lactation are very marked. In the earliest stage of activity, when the flow of milk first begins, many acini still retain their primitive condition of solidity: in such cases the elements occupying the central parts of the tubules undergo fatty degeneration, some becoming disintegrated, while others are cast off as masses which constitute the *colostrum-corpuscles* found in the milk during the first few days.

The uniformly granular protoplasm of the cells at rest becomes invaded by oil-drops when functional activity begins, and, as secretion progresses, it becomes broken up and displaced by the accumulation of oil-globules within the cell. The minute oil-drops exist at first as separate particles, which gradually increase in size until they become confluent and form a single large globule occupying the greater part of the entire cell. The nucleus in consequence is displaced toward the periphery, next the basement membrane, where it lies imbedded within the thin belt of protoplasm occupying the outer zone of the cell.

The cells within a single acinus generally contain very unequal amounts of oil; some of the elements are so loaded that the entire cell is occupied by the oil-drop, while, on the other hand, the neighboring cells may contain so little oil that the presence of the fatty particles is masked by the protoplasm. Between these extremes all gradations may be found.

Upon attaining a certain tension the contained oil-globules, escaping in the direction of least resistance, are discharged into the cavity of the acinus, where they, together with the granular débris of old epithelial cells, are collected within an albuminous fluid and constitute the *lactiferous secretion*, or milk. During secretion the acini possess a comparatively wide lumen, the epithelial layer forming but a thin lining to the irregular spherical or tubular spaces.

At the cessation of lactation the acini become once more reduced to narrow tubules, many being atrophic, surrounded by the thin preponderating areolo-adipose tissue. With each succeeding pregnancy a new period of cellular activity and new growth takes place in the preparation of the gland for its active rôle during lactation.

The close of the period of sexual activity is followed by gradual permanent atrophy of the secreting structures, so that secretions of the mammæ of aged women show little more than the atrophic remains of the sometime conspicuous gland-acini imbedded within the connective tissue which, with a variable amount of fat, now constitutes almost the entire bulk of the organ.

The blood-vessels of the mamma are derived from two sources: principally from the internal mammary artery, through its perforating branches within the second, third, and fourth intercostal spaces, and from the axillary artery through the thoracic branches, the long thoracic or external mammary artery often sending off robust twigs for the supply of the gland.

The veins returning the blood from the deeper part of the organ follow the corresponding arteries; the superficial veins form a subcutaneous plexus which becomes conspicuous during lactation.

The lymphatics are very numerous, as demonstrated by the brilliant preparations made by Sappey (Pl. 9, Fig. 3), and they constitute a superficial and a deeper set. The former exist as an intricate subcutaneous network in which the larger vessels are situated at the periphery, and join the lymph-paths converging toward the axilla. The deeper lymphatic vessels accompany the deeper veins and pass off in two groups: one set enters the axilla and terminates in the costal group of axillary lymph-glands; the other takes its course into the thorax and communicates with the chain of lymphatic nodules situated behind the sternum. The profuse supply of lymphatics and the intimate relations these bear to the lymph-glands situated deeply and at some distance greatly facilitate the conveyance of infectious materials to other parts, there to establish, as in the case of carcinoma mammæ, new foci of disease.

The nerves supplying the mammary gland are derived from the cervical plexus through the superficial descending supraclavicular branches, and from the fourth, fifth, and sixth intercostals; numerous sympathetic filaments accompany the latter into the substance of the gland.

Variations in the number and position of the mammæ have frequently been observed. While reduction in number or absence of these organs is extremely rare, increase in their number, as well as abnormal location, is by no means of great infrequency. The nipple alone may be involved, being either multiple or suppressed, or entire additional glands may be present.

Supernumerary mammæ have been observed in many locations, among which the arm, the axilla, various parts of the anterior body-wall, the back, the buttock, and the thigh are the most conspicuous. The interesting observations of O. Schultze on the presence of definite "milk-ridges" along the anterolateral aspect of the trunk in embryos, extending from the root of the upper limb to the inguinal region, suggest the location in which supernumerary mammæ are most frequently encountered, such superfluous organs resulting from the persistence and development of areas which ordinarily disappear. The presence of such markedly aberrant mammæ as those found on the back, the arm, or the buttock is less easily explained, since they arise probably in consequence of the unusual development of structures representing the ordinary sebaceous glands of the integument of the part.

III. Physiology of the Female Generative Organs.

1. **Ovulation.**—The differentiation of certain of the cells derived from the ingrowth of the germinal epithelium covering the young ovary into the sexual elements proper, the ova, takes place very early, so that at birth the formation of the ova is already nearly completed, the production of new cells after birth being very limited, and probably entirely ceasing after the second year (Bischoff, Waldeyer). The ovaries of the child of two years, therefore, contain the full quota of ova, although the vast majority of these cells always remain immature and undeveloped. The entire number of these primitive sexual elements stored up within the ovaries of the young child has been estimated at about seventy thousand. While it is probable that a variable number of the immature ova undergo partial development before puberty, yet the advent of sexual maturity at that period marks the establishment of the full

and regular development of the Graafian follicles and their contained ova, accompanied by the usual attendant phenomena of menstruation.

Throughout the entire childbearing period, or from about the fifteenth to about the forty-fifth year, the development of the Graafian follicles, terminating in the rupture of the follicles and the discharge of the ova, is continually occurring. The liberation of the ova usually takes place at definite times, which in general coincide with the menstrual epochs, one or more ova being set free at each period. This agreement, however, is by no means necessary or invariable, since *ovulation*, as the ripening and discharge of the sexual elements is termed, undoubtedly proceeds independently of menstruation.

The ripe *human ovum* is a typical spherical cell, about 0.2 millimeter in diameter, consisting of granular protoplasm or the *vitellus*, in which lies a nucleus or *germinal vesicle*, about 0.045 millimeter in diameter, containing a well-marked nucleolus, the *germinal spot*. The proper cell-wall is the *vitelline membrane*, a structure of great delicacy, and often overlooked, outside of which the ovum is invested by the conspicuous *zona pellucida* (about 0.01 millimeter thick), which must be regarded as a secondary envelope contributed by the cells of the surrounding discus proligerus.

The fully-developed Graafian follicle is ovoid, and consists of an external investment of vascular connective tissue, the *tunica fibrosa*, which is lined by a thick layer of granular polyhedral epithelial cells, the *membrana granulosa*. At one point these cells are continued as a mass which immediately invests the ovum and which is known as the *discus proligerus*. The interior of the well-

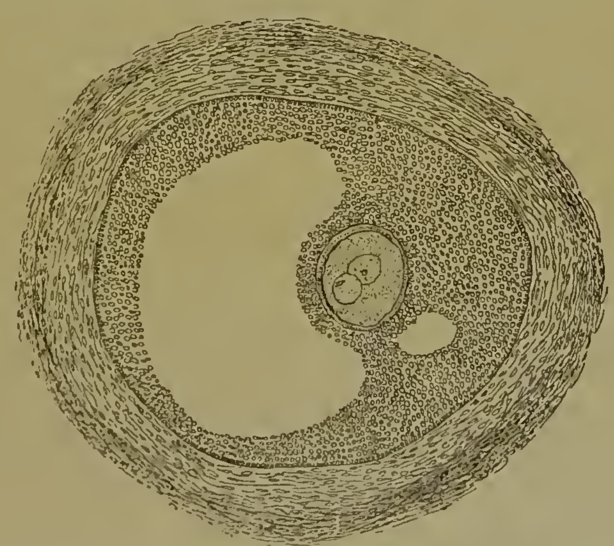


FIG. 61.—Section of well-developed Graafian follicle from human embryo (Von Herff); the enclosed ovum contains two nuclei.

developed follicle (Fig. 61) contains a fluid, the *liquor folliculi*, separating the ovum and its surrounding discus from the opposite wall of the sac. The most prominent part of the ripe follicle is less vascular than those parts subjected to less pressure, one spot, the *hilum folliculi*, being free from blood-vessels, and corresponding with the point at which the distended matured sac, from 2 to 4 millimeters in diameter, finally ruptures.

2. **Menstruation.**—At regular intervals throughout the childbearing period the lining of the uterus undergoes changes primarily designed to prepare a favorable resting-place for the product of conception. In the case of the non-occurrence of pregnancy these changes terminate in the disintegration of the uterine mucous membrane and in the discharge of blood, mucus, and tissue-débris that constitutes the phenomena of menstruation. Should pregnancy occur, menstruation is, as a rule, suspended during the entire time that the embryo is within the uterus, reappearing usually from six to eight weeks after the birth of the child. Exceptions to the customary prompt cessation of menstruation are by no means infrequent, the catamenial phenomena often recurring with regularity during the early months of gestation. The anatomical explanation of this variation is found in the fact that the uterine cavity is not obliterated by the apposition of the decidua reflexa against the mucous membrane of the uterus or the decidua vera until the end of the fifth month. The very rare occurrence of the menses throughout gestation is probably associated with an abnormal and imperfect fusion of the deciduæ. The reputed instances of women menstruating only during pregnancy must be viewed with suspicion, since the discharge in such cases probably always results from pathological conditions of the cervical canal.

The complete menstrual cycle, which typically occupies twenty-eight days, may be divided into four stages (Marshall), following one another in regular sequence and lasting a definite proportion of the entire period:

(1) The first or *constructive stage* is one of preparation for the reception of an ovum, and is characterized by the formation of a menstrual decidua in the preparation of which swelling of the mucous membrane, enlargement of the uterine glands, and increase of the connective tissue all take place. This stage probably lasts about one week, and is followed, when pregnancy has not occurred, by degenerative changes.

(2) The second or *destructive stage* is marked by the destructive processes which give rise to the usual phenomena of the menstrual period, including the discharge of mucus, blood, and disintegrated uterine mucous membrane. Five days constitute the average duration of the menstrual flow, although its continuance may be extended or curtailed, owing to individual peculiarities.

(3) The third or *reparative stage* is one of repair, during which the deeper and unaffected parts of the uterine mucous membrane institute constructive processes which within the short period of from three to four days result in the formation of a new mucosa.

(4) The fourth or *quiescent stage* includes the remaining twelve or fourteen days of the menstrual cycle, and represents the quiescent period preceding the initiative changes marking the beginning of the next period.

The relations between ovulation and menstruation are of great interest, for, although the discharge of the ripened ovum and of the degenerated uterine decidua takes place usually simultaneously, it is well established that it is neither invariably nor necessarily so, since authenticated observations have shown that menstruation may be unattended by the liberation of an ovum. While these two processes, as a rule, may be regarded as associated, the determination of the exact relation between the discharged ovum and the uterine changes coincidently taking place is not yet positively established. It may be assumed that the first or constructive stage in the cycle of uterine changes is particularly favorable for the reception of the ovum : this being the case, it is evident that the preparation of the uterine mucous membrane cannot be directed toward the reception of the ovum, whose discharge takes place with the coincident menstrual phenomena, since it is probable that at least a week is occupied in the transit of the egg from the ovary to the uterus. Marshall's conclusions, that "the decidua of a particular menstrual period is related, not to the ovum discharged at that period, but to the ovum discharged at the preceding period," are fully warranted by the more exact data furnished by careful observation. The well-known coincidence of ovulation and menstruation finds its partial explanation, at least, in the marked congestion of the ovaries and the consequent stimulation and vascular engorgement which the uterus experiences by reason of the close arterial anastomoses between the vessels of these organs, the resulting turgescence probably being an important factor in establishing the menstrual flow.

II. PREGNANCY.

I. PHYSIOLOGY OF PREGNANCY.

I. Development of the Embryo and the Fetus.

1. Maturation and Fertilization.—Coincident with the growth of the Graafian follicle, which culminates in the rupture of the sac and the discharge of the liquor folliculi and the egg surrounded by the discus proligerus, the ovum passes through a series of changes collectively termed *maturation*, by which the female sexual cell is prepared for the reception of the male element, without the completion of which preparation fertilization of the ovum is impossible.

The maturation of the ovum consists essentially in the very *unequal* and *repeated division* of the egg, by which two minute portions of its substance,

Fig. 62.—Portions of ova of *Asterias glacialis*, showing changes affecting the germinal vesicle at the beginning of maturation (Hertwig): *a*, germinal vesicle; *b*, germinal spot, composed of nuclein and paranuclein (*c*); *d*, nuclear spindle in process of formation.

the *polar bodies*, are extruded; the remainder of the cell after the completion of this cycle returns to a quiescent condition to await the advent of the male sexual element. Maturation takes place entirely independently of the influence of the male or of the probability of fertilization, every healthy ovum undergoing these changes before it becomes sexually ripe.

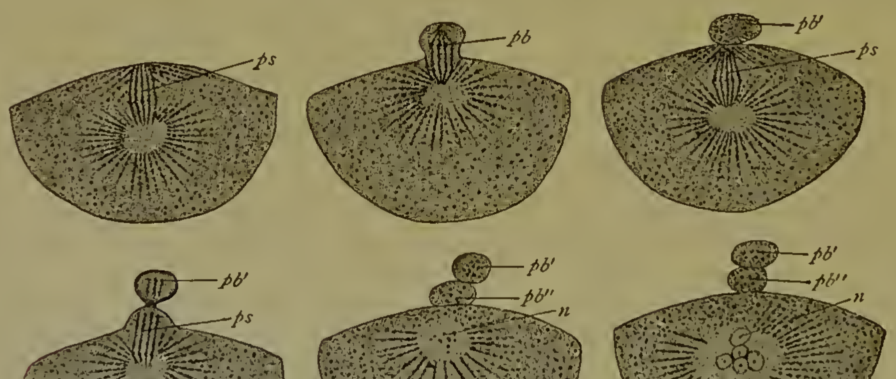


Fig. 63.—Formation of polar bodies in ova of *Asterias glacialis* (Hertwig): *ps*, polar spindle; *pb'*, first polar body; *pb''*, second polar body; *n*, nucleus returning to condition of rest.

The process, in brief, consists of the following phases: (*a*) The migration of the germinal vesicle or nucleus toward the periphery of the cell (Fig. 62); (*b*) the rupture and the disappearance of the nucleus, and the formation of the nuclear spindle and other elements of the complicated cycle of indirect cell-division; (c) the extrusion of a minute portion of the ovum as the *first polar body* (Fig. 63); (d) short quiescence followed by a repetition of division, resulting in giving off the *second polar body*; (e) the establishment of equilibrium, the appearance of a new and smaller nucleus, the *female pronucleus*

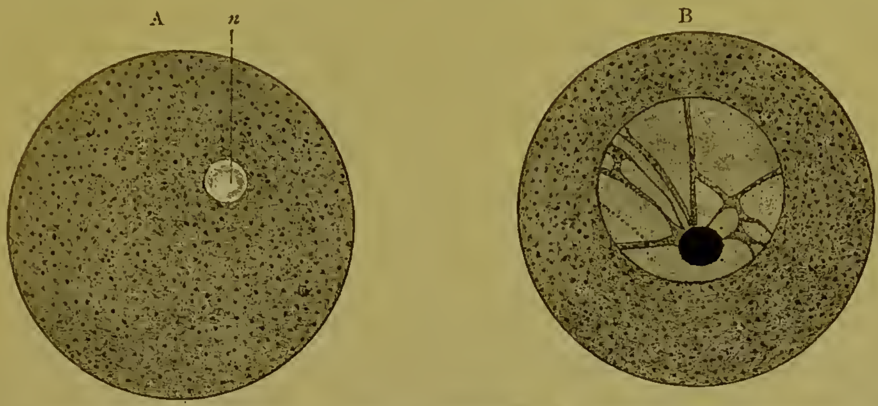


FIG. 64.—A, mature ovum of echinus: *n*, female pronucleus; B, immature ovarian ovum of echinus (Hertwig).

(Fig. 64), and the return to a condition of rest. Maturation usually takes place just before the rupture of the follicle and the escape of the ovum.

On the completion of the phenomena of maturation, the ovum is prepared for the reception of the male element, the meeting of the sexual cells in mammals usually taking place within the upper portion of the oviduct.

The number of the more vigorous seminal elements deposited within the vagina that work their way through the uterine cavity and into the oviducts must be but an insignificant part of the entire number lodged about the external os. Of those, moreover, fortunate enough to overcome the obstacles pre-

FIG. 65.—Portions of the ova of *Asterias glacialis*, showing the approach and fusion of the spermatozoön with the ovum (Hertwig): *a*, fertilizing male element; *b*, elevation of protoplasm of egg; *b'*, *b''*, stages of fusion of the head of the spermatozoön with the ovum.

sented to their progress within the uterus and tubes, but a single spermatozoön actually takes part in the fertilization of the ovum.

After reaching the surface of the egg and penetrating the zona pellucida, the successful spermatozoön is met by a slight projection of the protoplasm of the ovum, with which the head of the male element soon becomes blended (Fig. 65). The tail is lost, and the head later sinks within the substance of the egg. Subsequently the position of the impregnating element is indicated by the appearance of a small round or ovoid body, the *male pronucleus* (Fig. 66, A, B), whose vicinity is rendered conspicuous by the radial striation marking the surrounding protoplasm. The male and female pronuclei now approach, and sooner or later meet and become blended, their union producing the *segmentation-nucleus* (Fig. 66, C) from which are formed the new generations of elements, to the constitution of which both parent-cells have contributed.

It is of interest to note that, since the parts of the sexual cells most concerned in the production of the segmentation-nucleus are rich in chromatin, a fusion of the nuclein seems to be the essential feature of the process of fertilization. The blending of both parent-cells within the segmentation-nucleus furnishes the explanation as to the fundamental manner of transmission to the offspring of the individual peculiarities of both father and mother, since the new being depends for its origin upon a nucleus to which both parents have contributed and by which the characteristics of both are perpetuated.

Should the matured female element fail to meet the spermatozoön, the ovum after a few days loses its vitality and perishes. The period during which the human egg retains the possibility of fertilization has been variously estimated, about eight days being the probable limit of the retention of this power, since the death of the unfecundated ovum usually occurs before the egg reaches the uterus.

2. **Segmentation.**—The meeting and fusion of the male and female pronuclei, already described, result in the formation of the new segmentation-nucleus (Fig. 66, C), whose appearance institutes the process of cell-division by

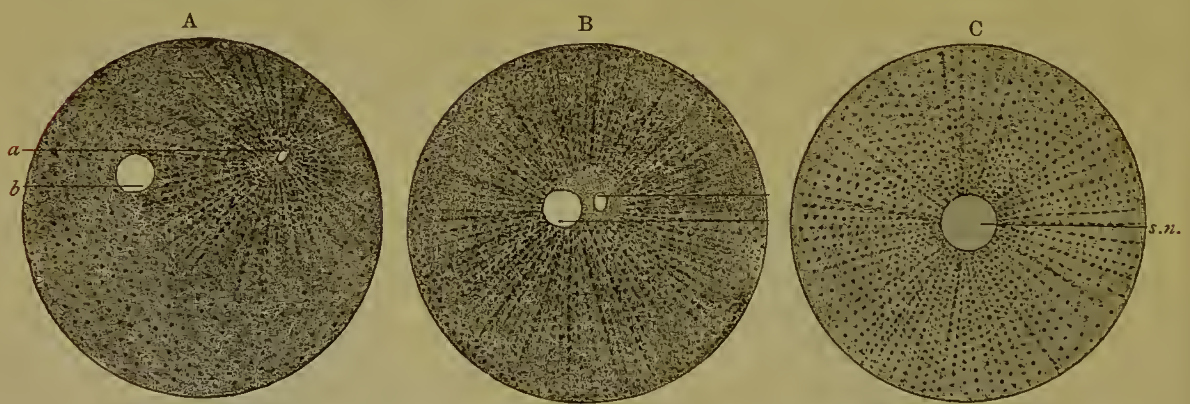
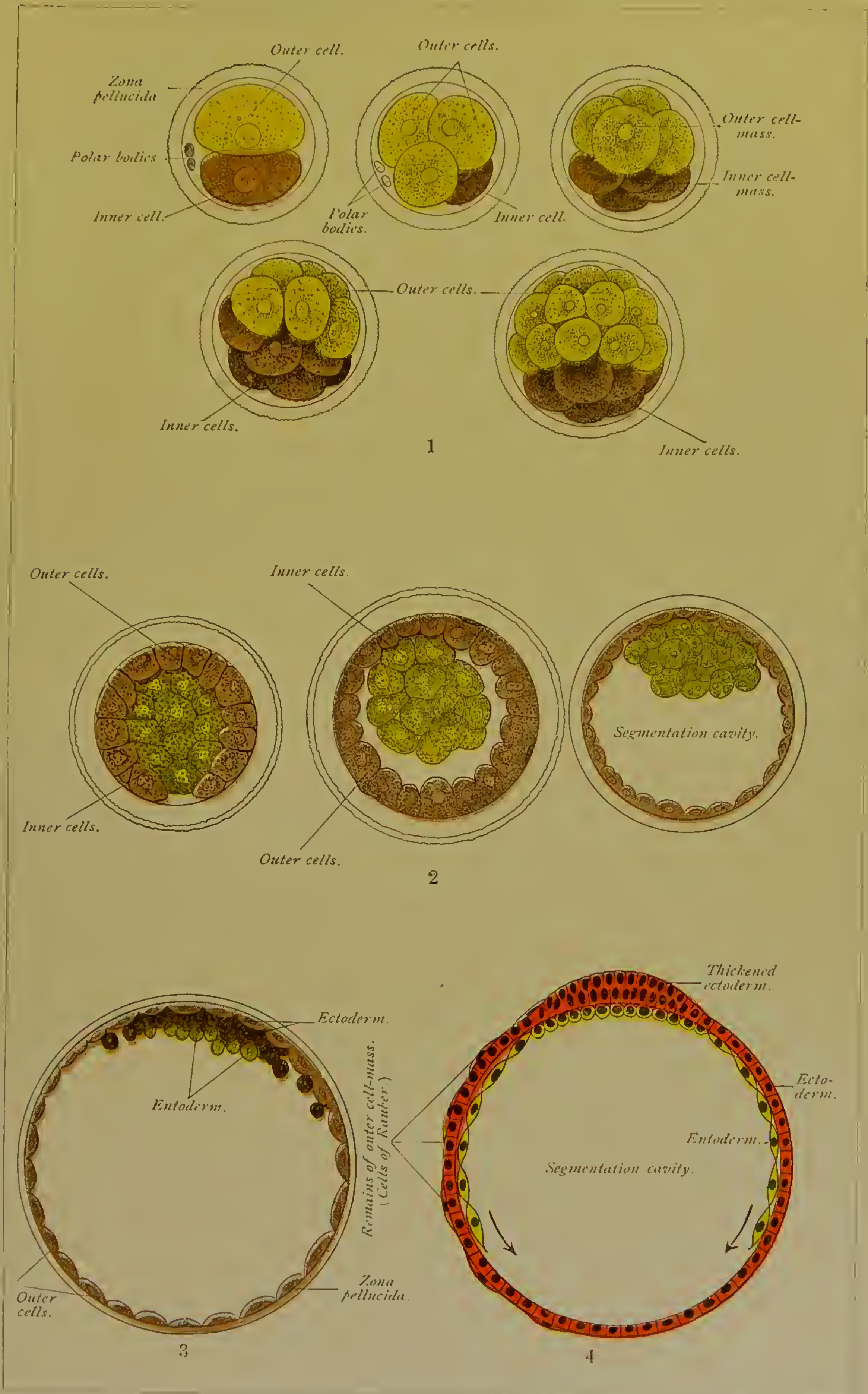


FIG. 66.—A, fertilized ova of echinus (Hertwig): the male (*a*) and the female pronucleus (*b*) are approaching; in B they have almost fused; C, ovum of echinus after completion of fertilization (Hertwig): *s.n.*, segmentation-nucleus.

which the original egg-cell gives rise to an extended series of generations, leading to the production of the blastoderm.

Since the youngest human embryo carefully examined and recorded—that of Reichert—was already probably twelve days old, the early phenomena of impregnation and segmentation have never been observed in man. Direct observations upon higher mammals, as the dog and the rabbit, have supplied our knowledge of the details of these early stages of development, which, in the main, probably closely correspond with the changes taking place within the human ovum. Nagel's examination of a ripe human ovum and the dis-



SEGMENTATION.—1–3. Diagrams illustrating the segmentation of the mammalian ovum (Allen Thompson, after E. v. Beneden). 4. Diagram representing the relation of the primary layers of the blastoderm (Bonnet).

covery of the presence of two polar bodies, as in other mammals, still further justifies the assumption of this similarity.

The minute amount of food-yolk possessed by the mammalian egg is uniformly distributed throughout its protoplasm, and is not collected as a distinct body; such ova are therefore known as *alecithal*. As influenced by the amount and arrangement of the yolk, these ova experience entire cleavage during their division, and are said to undergo total segmentation, being therefore *holoblastic*. Since the resulting cells may be regarded as practically equal in size, their type of segmentation may further be designated as *equal*. The human ovum, therefore, is technically described as an alecithal, holoblastic egg undergoing equal segmentation.

Almost directly after the appearance of the nucleus of segmentation, the phenomena of cell-division appear within the parent-cell, the cycle resulting in the formation of the first pair of daughter-cells (Pl. 10, Figs. 1–3). These cells in turn become the seat of similar activity by which four cells are produced, the process of cell-division continuing until the original element is represented by many generations of direct offspring. While, for convenience, the segmentation of the mammalian egg may be regarded as equal, yet, when closely examined after the third or fourth cleavage, a slight difference may be noted in the size of the resulting elements, or *blastomeres*. This discrepancy, insignificant in its individual variation, becomes gradually manifested by the separation of the blastomeres into an *inner* and an *outer cell-group*, the cells of the outer group undergoing more rapid increase than those of the inner group, which latter cells, in consequence of this inequality in growth, gradually are invested by an enveloping layer composed of the outer cells (Pl. 10). This process of covering-in progresses until the outer cells constitute a complete envelope, the entire segmented ovum now corresponding with the mulberry mass, or *morula*, of the older anatomists.

Examined in section, the ovum at this stage consists of the single layer of outer cells, to the inner surface of which at one point adheres the less-expanded group composed of the inner cells, the space between the two, the *segmentation-cavity*, being occupied by a clear albuminous fluid. This stage of the hollow sphere of the mammalian ovum is known as the *blastula* or *blastodermic vesicle* (Pl. 10, Fig. 4).

The further changes within the blastula are marked by the rapid and enormous increase in the size of the ovum, in consequence of which increase the outer cell-layer undergoes great extension, with corresponding attenuation of its elements, which are changed into thin, scale-like plates.

Coincidently with these changes affecting the layer of outer elements, the group of inner cells has undergone an important although inconspicuous modification, in consequence of which a differentiation of these cells into a rapidly proliferating peripheral layer, next the thinned-out stratum of investing outer cells, and a more slowly dividing central mass has taken place (Pl. 10, Figs. 1–3). This peripheral layer is the primitive *ectoderm proper;* the inner mass is the primitive *entoderm*.

With the growth of the ectodermic layer the primary outer cells become more attenuated, and after a time blend with the developing ectodermic tissue, the two together constituting the early true ectoderm. When this structure is examined its surface is found covered with flat elements, fusiform in profile, known as *Rauber's cells* (Pl. 10, Fig. 4), which later disappear and seemingly take little or no *rôle* in the formation of the permanent ectodermic structures. The cells of Rauber are probably the remains of the attenuated layer of the primary outer cells. The ectoderm expands on all sides until the entoderm as well as the entire yolk-cavity of the ovum is completely enclosed.

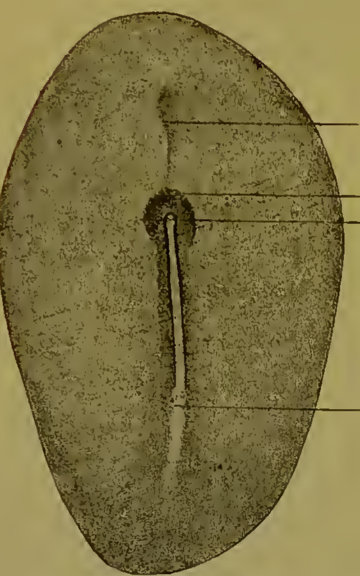


FIG. 67.—Embryonic area of rabbit embryo (E. v. Beneden): primitive streak beginning in cell-proliferation, known as the "node of Hensen."

If a mammalian ovum at about this stage be examined from the surface, the blastodermic vesicle on one side presents an oval or pyriform field of greater density: this is the *embryonal area*, and corresponds to that portion of the blastula especially concerned in the development of the embryo. Very early a linear opacity known as the *primitive streak* (Fig. 67) makes its appearance at the smaller or posterior pole of the embryonal area, and seemingly grows forward toward the centre of this field.

On section the primitive streak is seen to depend upon a line of proliferating tissue which marks the position of fusion and intimate union of all the embryonal blastodermic layers (Figs. 68, 69). Very soon the primitive streak becomes occupied by a median longitudinal furrow, the *primitive groove*. The significance of this pre-embryonic structure is still a subject of much discussion. Without entering into the details of the somewhat theoretical and complicated considerations of the subject, it may be mentioned that there are ample grounds for accepting the views of His, Minot, and others that the primitive streak of the higher types represents morphologically the fusion of the lips of the *blastopore*—the opening formed among the lower types by the invagination of the blastodermic vesicle at one point in the production of the *gastrula stage*.

In contrast with the usual appearance of mammalian ova, the early human ovum is characterized by the precocious development of villous projections, so that as early as the twelfth day, as represented by Reichert's ovum (see Fig. 83), its exterior presents well-marked elevations. These villi, however, are not uniformly distributed over the ovum, but are limited to the marginal zone of the compressed spherical egg, the two flattened sides being smooth and devoid of villi. The embryonic area corresponds in position with one of the poles of the shorter axis of the ovum that connects the smooth sides, although at this stage little if any trace of the embryo is to be seen.

Coincidently with the further growth and differentiation of the two-layered blastula, a third layer, the *mesoderm*, makes its appearance (Fig. 68). The origin of this lamina is still a subject of much discussion, but it may be accepted as demonstrated that the mammalian mesoderm arises from two sources—principally by a splitting off or delamination from the entoderm,

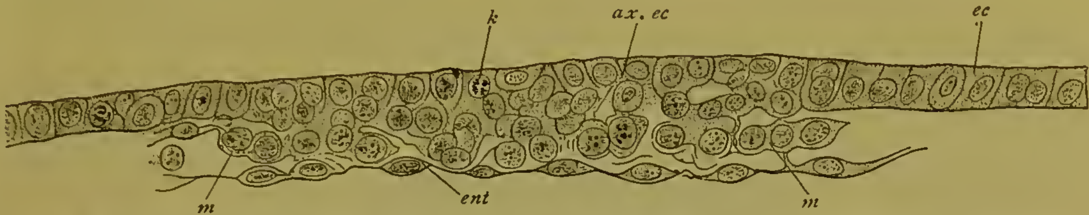


Fig. 68.—Section across the primitive streak of rabbit embryo (Kölliker): *ec*, ectoderm; *ax. ec*, axial ectoderm undergoing proliferation, as shown by karyokinetic figures (*k*); *ent*, entoderm; *m*, mesoderm.

supplemented by a proliferation involving the ectoderm along the anterior part of the primitive streak. This latter structure therefore marks the axis along which complete fusion of the three blastodermic layers takes place before the formation of the true embryo has started. The primitive streak is a transient structure, and gives rise to no part of the embryo; later it entirely disappears.

The growth of the mesoderm is rapid, and soon produces a layer particularly developed toward the caudal pole of the embryo, expanding in broad lateral fields on either side. Viewed as a whole, the mesodermic sheet appears pyriform, with its smaller end directed anteriorly or opposed to the corresponding part of the embryonal area. At first a continuous layer, the

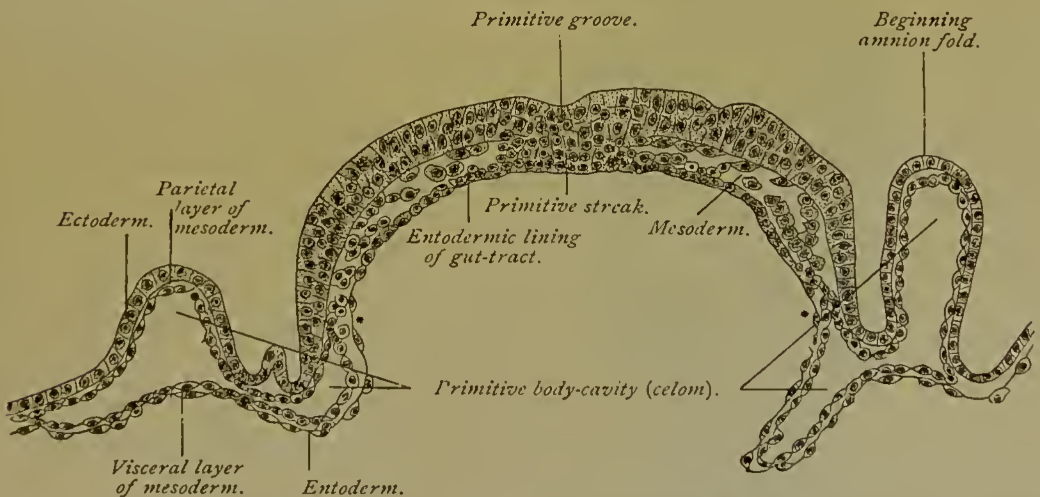


Fig. 69.—Transverse section of the embryonic area of a fourteen and a half day ovum of sheep (Bonnet).

mesoderm later becomes displaced along the immediate axis of the embryo, this division resulting in the formation of two closely approximated but separated halves: in each of these a *paraxial* and a *lateral tract* are further to be recognized. The latter undergoes cleavage by the formation of the intramesodermic *body-cavity* or the *celom* (Fig. 69); the resulting upper and lower lamellæ constitute respectively the parietal and visceral layers of the mesoderm. The parietal or somatic layer joins the ectoderm to form the *somato-*

pleure; the visceral or splanchnic layer unites with the entoderm to form the *splanchnopleure* (Fig. 70). These structures later produce the body-walls and the walls of the primitive digestive tube.

About the end of the second week the human ovum enters upon the earliest initial stages of the formation of the embryo proper. In addition to

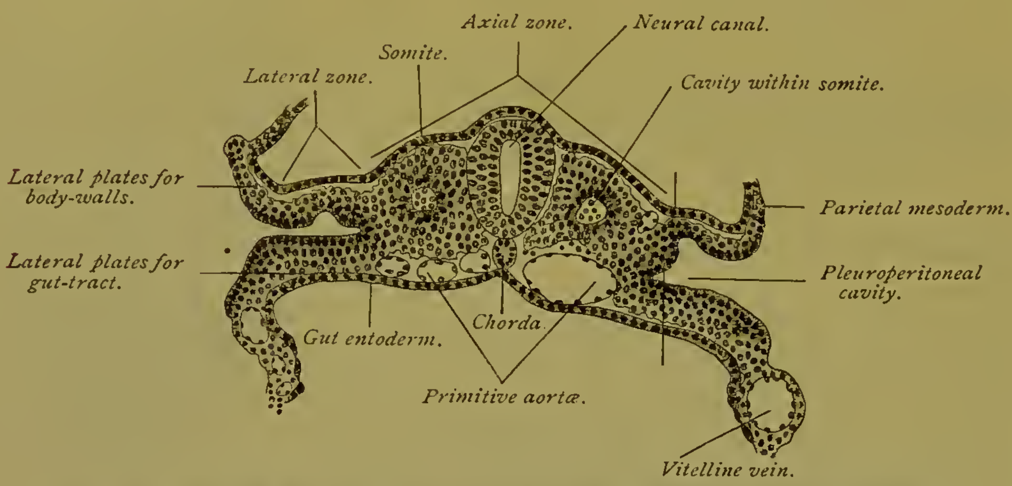


FIG. 70.—Transverse section of a seventeen and a half day sheep embryo (Bonnet).

the primitive streak, which, as above stated, is a transient structure having nothing directly to do with the embryo, the fundamental developmental processes include the formation of the *neural folds* and the *neural canal,* the *chorda dorsalis* or *notochord,* and the *somites* or *provertebræ.*

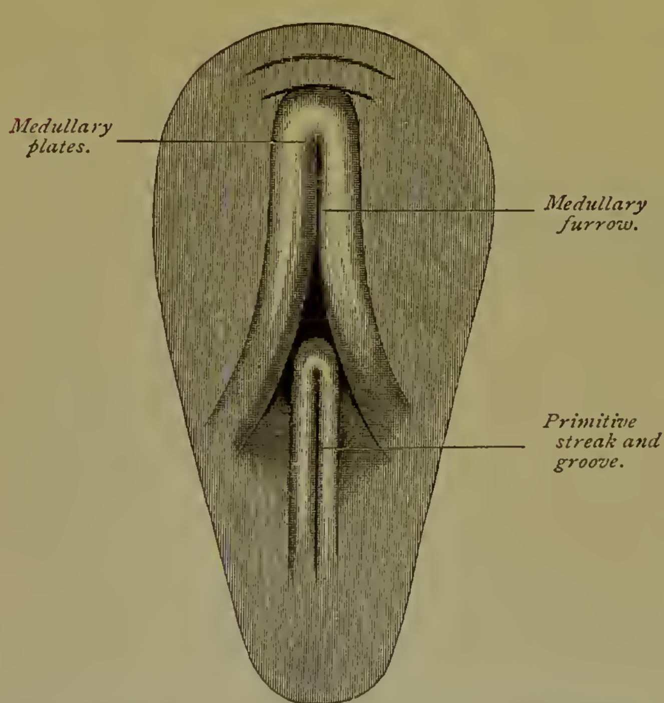


FIG. 71.—Surface view of area pellucida of an eighteen hour chick embryo (Balfour).

Neural Canal.—The development of this structure consists first in the appearance of the *neural* or *medullary folds,* which together constitute a Λ-shaped duplicature embracing the anterior extremity of the primitive streak; by the thickening and the approximation of the summits of these folds the *neural* or *medullary groove* is produced (Fig. 71). This furrow is later converted into the neural canal, the early representative of the nervous system, by the further growth and union of the folds along the dorsal line of contact, the closure being first effected near—not, however, at—the cephalic extremity of the embryo, but some little distance farther caudally, at a position which later corresponds with the cervical region of the spinal cord. The extreme cephalic end of the neural canal undergoes expansion into three primitive brain-vesicles. The neural folds of the caudal portion for a long time remain widely separated.

Chorda Dorsalis.—The appearance of the *chorda dorsalis*, or the *notochord*, establishes the earliest representative of the *longitudinal axis* which constitutes the fundamental characteristic of all vertebrates. While the earliest development of this structure has not been observed in man, it is fair to assume a close correspondence with the process as studied in other mammals. In these the mesial portion of the entoderm gives rise to a cell-group (Fig. 72) which gradually becomes separated from the inner layer and displaced, so that the

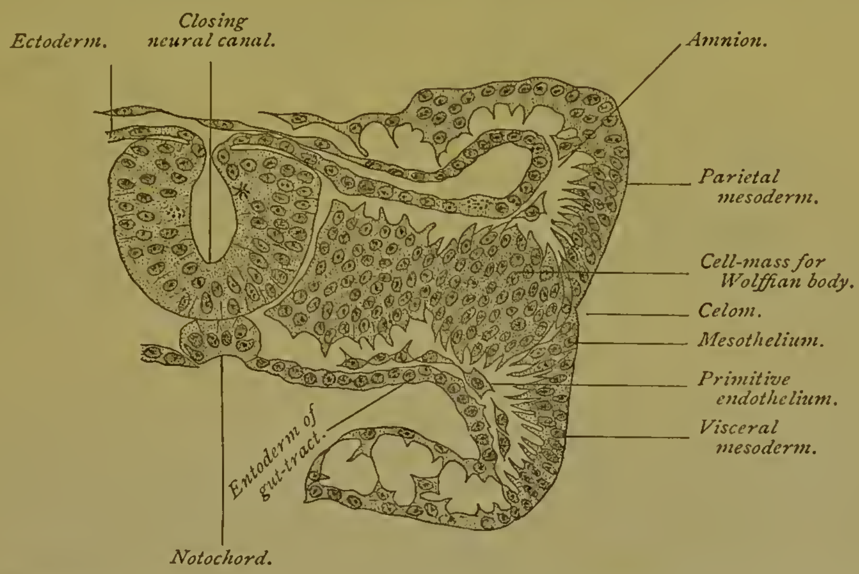


FIG. 72.—Transverse section of a fifteen and a half day sheep embryo possessing seven somites (Bonnet).

resulting cell-mass forms a slender cylinder which stretches from the anterior extremity of the embryo to its caudal pole. On section the notochord appears as an oval group of cells situated immediately beneath the neural groove or canal and above the entodermic layer (Fig. 74). The notochord, for a time representing the longitudinal axis of the embryo, is usually replaced by the permanent vertebral axis, at first cartilage and later bone. The remains of this embryonal structure in man are seen in the central areas of spongy material occupying the intervertebral disks.

Somites.—The formation of the *somites* or *provertebræ* marks the establishment of the segmentation which later is permanently effected by the development of the vertebræ and the associated parts of the trunk. The production of the somites is so closely related to that of the mesoderm that the primary arrangement of this important sheet must be recalled. After its origin from the double source of entoderm and ectoderm, the mesoderm rapidly expands laterally, the growth being particularly active toward the caudal pole of the embryo, in consequence of which the layer becomes pyriform in outline when seen from its upper surface. At first a continuous sheet, the further development of the neural groove from above downward and of the notochord from below upward soon divides the mesodermic tract along the embryonic axis into two great wings (Fig. 73).

Each of these wings undergoes further differentiation into a paraxial band next the mid-line, and a lateral plate which blends away laterally into the

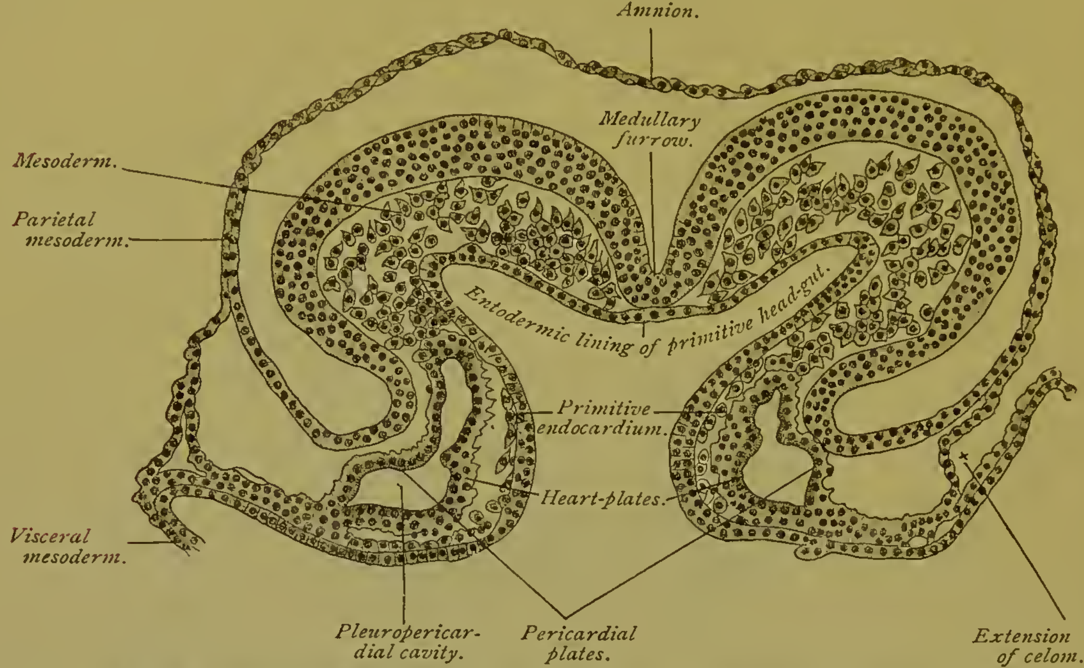


FIG. 73.—Transverse section of a sixteen and a half day sheep embryo (Bonnet).

widely extending mesodermic area (Fig. 74). The lateral mesodermic plate undergoes cleavage into an upper and a lower lamina which respectively adhere to the ectoderm and the entoderm. The upper and outer of the resulting two-layered lamellæ constitutes the *somatopleure;* the under and inner one,

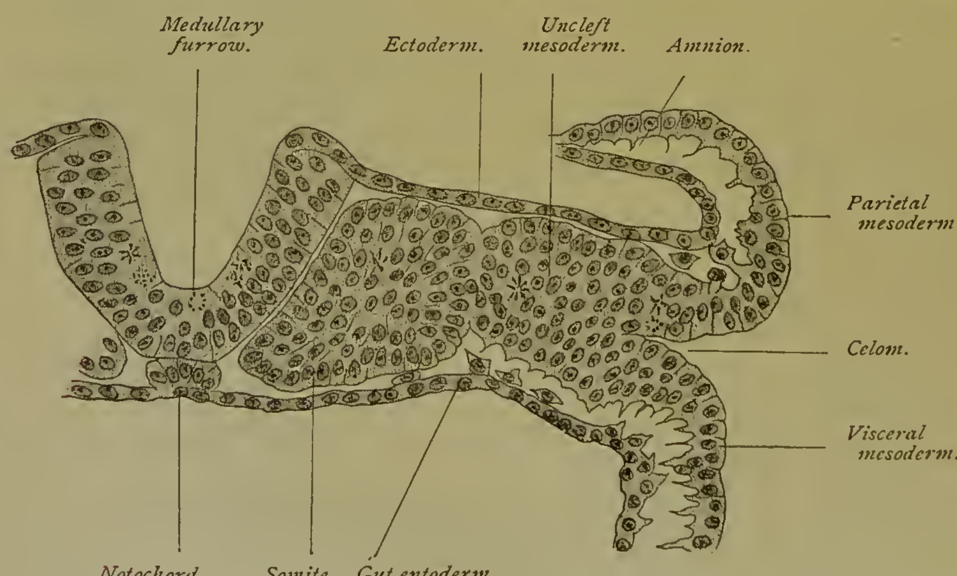
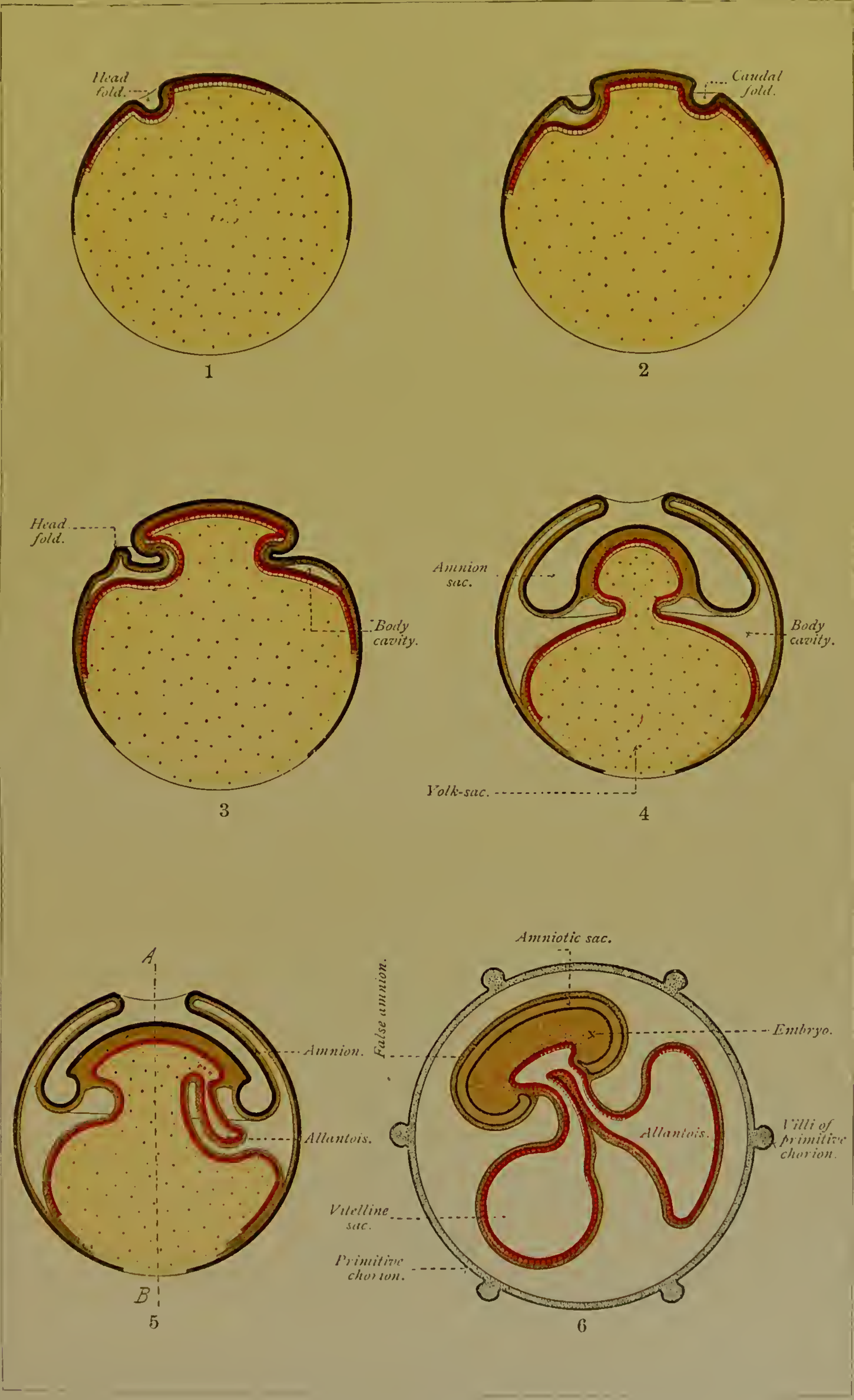
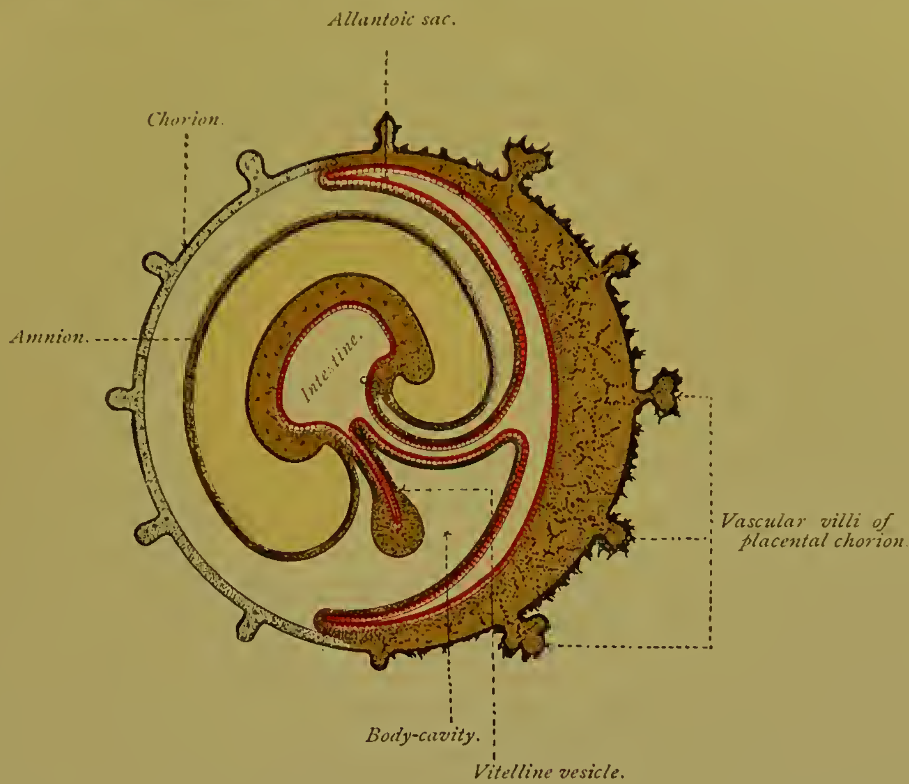


FIG. 74.—Transverse section of a sixteen and a half day sheep embryo possessing six somites (Bonnet).

the *splanchnopleure.* The space included between the two leaves of the cleft lateral mesoderm is the *primitive body-cavity* or *celom,* which afterward becomes the pleuro-peritoneal cavity.



1-6. Diagrams illustrating the formation of the mammalian fetal membranes (modified from Roule).



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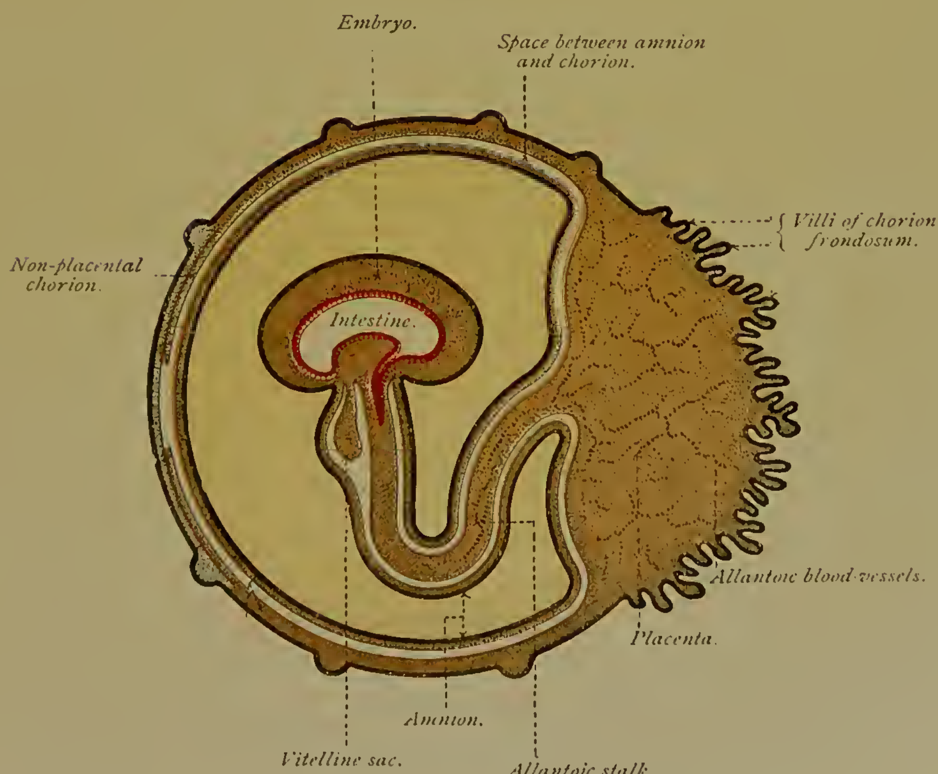

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1, 2. Diagrams illustrating the later stages of the formation of the mammalian fetal membranes (modified from Roule).

The *paraxial* band of mesoderm does not undergo cleavage as do the neighboring lateral mesodermic areas, but instead it suffers a transverse division into a series of small quadrilateral areas, the *somites* or *provertebræ*. These areas first appear immediately behind the cephalic expansion of the neural canal and progress toward the caudal pole, at particular stages of the human embryo, as from the twenty-first to the thirty-fifth day, forming a series of conspicuous markings on each side of the dorsal mid-line as far as the extreme caudal extremity (Fig. 129).

The somites are transient and are not represented by adult structures, since the segmentation of the permanent vertebræ which later appears does not correspond with that of the somites, the areas producing the vertebræ falling in such manner that portions of the somites are embraced by a single vertebra. While not directly related to the formation of the vertebral column, the somites contribute to the production of the important muscular tissues, since the outer portions of their masses become converted into peculiar flattened bands, the *muscle-plates*, from which proceeds the development of the great tracts of voluntary muscle, at first of the trunk, later of the limb appendages.

3. **Fetal Membranes.**—Coincidently with the progress of the fundamental processes just described, the formation of envelopes for the protection and establishment of means for the further nutrition of the embryo takes place: these envelopes are known as the *fetal membranes* (Pls. 11, 12), which, in connection with the structures derived from the thickened uterine lining, constitute the membranes thrown off at birth.

The amnion (Pl. 11, Figs. 4, 5), the earliest of the envelopes, appears soon after the formation of the neural folds and groove as duplicatures of the somatopleure which start in front, behind, and at the sides of the embryo. The anterior amniotic fold in man grows with unusual rapidity, and, aided by the lateral folds, soon covers in the embryo from before backward, the caudal extremity being the last to be enveloped. The line of union of the several duplicatures has received the name *amniotic suture*. Examined in section, the amnion is seen to comprise not only the ectodermic tissue, but also the extension of the parietal or somatopleuric layer of the mesoderm. On reference to the Figures of Plate 11 this relation will be seen illustrated, as well as the mode by which the folds meet over the dorsal surface of the embryo to form the amniotic sac, which, when entirely closed, contains the amniotic fluid separating the envelope from the developing animal. While union and fusion of the innermost layers of the ecto-mesodermic folds of the somatopleure produce the true amnion with its contained sac lined with ectoderm, the separation of the fused outer laminæ of the duplicatures from the amniotic portion gives rise to a second externally-lying envelope, the *false amnion*, or *serous membrane*, in which the disposition of the component layers is reversed, since the ectoderm lies without, and the mesodermic tissue next the included space. The latter is directly continuous with the interval between the parietal and visceral laminæ of the cleft mesoderm, and is the extra-embryonal portion of the primitive body-cavity, which thus extends widely beyond the limits of the embryo proper.

With the accumulation of the liquor amnii the amnion becomes separated from the embryo and is pushed against the surrounding envelopes.

The amniotic fluid, or *liquor amnii*, is a serous fluid produced probably by the amnion itself, having a specific gravity varying from 1.007 to 1.008; it contains from 1.07 to 1.06 per cent. of dry solids (Prochownick). The amount of the amniotic fluid is subjeet to great variation, the average quantity at full term being between 700 and 800 cubic centimeters, or less than one liter. Notwithstanding numerous investigations, there appears to exist no constant relation between the quantity of the amniotic fluid and the weight of the child or of the after-birth. In addition to the evident use of the fluid for the mechanieal protection of the embryo, it is probable that it affords a source of water to the developing animal, since there is strong evidence to show that the fluid is continually swallowed during the greater part of intra-uterine existence. Toward the later months of gestation the pressure induced by the growing fetus and the large amount of the amniotic fluid pushes the amnion into close contact with the surrounding false amnion, the two becoming closely, although not inseparably, united by the end of gestation.

As the embryo gradually assumes a more definite general form, the roots of the true amniotic folds sink more and more ventrally until they meet, thus closing in the body-cavity and forming its anterior wall. In the early stages, when the yolk-sac or umbilical vesicle communicates with the widely open gut-tract by means of its broad stalk, approximation of the somatic plates is prevented. With the decrease of the umbilical vesicle and the corresponding diminution in its stalk the ventral plates grow together and rapidly close the pleuro-peritoneal cavity except at one point, the umbilical opening, through which pass those structures that connect the embryo with organs lying without its body, as the umbilical and allantoic blood-vessels and stalks with their aecompanying lumina.

The Allantois.—The *allantois* appears as an outgrowth from the hind-gut (Pl. 11, Figs. 5, 6) after the primitive digestive tube has become well defined and partially closed. When typically developed the allantois grows out as a free sac into the spaee between the true and the false amnion, rapidly increasing in size. In man, however, the allantois at no time exists as a free vesicle, since it almost at once forms attachments with the structures extending from the caudal extremity of the human embryo as the *abdominal stalk* (Fig. 75), in which is included the lumen of the imprisoned allantoic sac.

The primary function of the allantois is to act as a receptacle for the exeretory allantoic fluids thrown off by the Wolffian bodies, by which primitive organs the effete matters are removed as by the kidneys at later stages. Subsequently the allantois takes an important part in building up the chorion, from which the fetal eontribution to the nutritive apparatus of the plaeenta is directly derived.

The abdominal stalk is peculiar to the human embryo, in whieh it very early appears as a pedunculated extension of its caudal portions to the surrounding false amnion, over whieh it expands and with whieh it fuses, the allantoic tissue taking part in the formation of the chorion (Pl. 12, Fig. 1). The allantois in man, therefore, is never free, and finds its expression in the entodermic diverticulum, which passes from the hind-gut through the abdominal stalk toward the chorion.*

Whatever its initial mode of formation, the allantoic tissue grows with rapidity and extends over the inner surface of the false amnion, with which it soon becomes intimately united, the two membranes together constituting the *chorion*, a structure of much importance in providing for the nutrition of the embryo during the last two-thirds of its intra-uterine sojourn, by reason of its active participation in the formation of the placenta.

The allantois being a direct outgrowth or evagination of the primitive gut, its wall consists of an inner entodermic and an outer mesodermic layer—extensions of the splanchnopleuric tissues forming the digestive tube. Coincidently with the later development of the allantois, blood-vessels extend from the arterial trunks of the embryo within the mesodermic layer of the sac and invade this tissue, which has become closely united with the false amnion in their joint production of the chorion.

FIG. 75.—Diagrammatic sections representing growth and arrangement of the amnion in the earliest stages of the human embryo (His).

The chorion, covered with simple and compound villi, is at first devoid of blood-vessels, and is composed of the ectodermic and entodermic layers on its outer and inner surfaces, between which lies the thicker lamella formed by the fused amniotic and allantoic mesodermic strata. Shortly after the establishment of the chorion, the arteries conveyed by the allantois spread out within the mesodermic layer of the chorion and invade the villi, which then display vascular loops within their characteristic leaf-like, club-shaped processes. These processes often consist of a main primary stalk from which secondary twigs branch, from which diverge the ultimate leaves.

* The term "chorion" is here used in a restricted sense as indicating the membrane resulting from the fusion of the false amnion and the allantoic tissue; by some authors (Minot) the "chorion" represents the entire extra-embryonic somatopleure, which gives rise alike to the true and the false amnion.

The form and arrangement of the villi vary somewhat with the duration of pregnancy: at the third month, or when the placenta is formed, the villi are short, thick-set, and of irregular shape; later they become less irregular, and the secondary branches leave the parent stems less acutely; finally, at full term, the villi are more regularly disposed and their branches have become long and slender and less closely set. The recognition of the villi of the chorion is often a matter of much practical importance, since their presence, as determined by microscopical examination of suspicious matters discharged *per vaginam*, is positive evidence of the existence of pregnancy. Their peculiar arrangement, and their flattened, petal-like form, together with their vascular connective-tissue stroma and epithelial covering, usually suffice to establish the diagnosis.

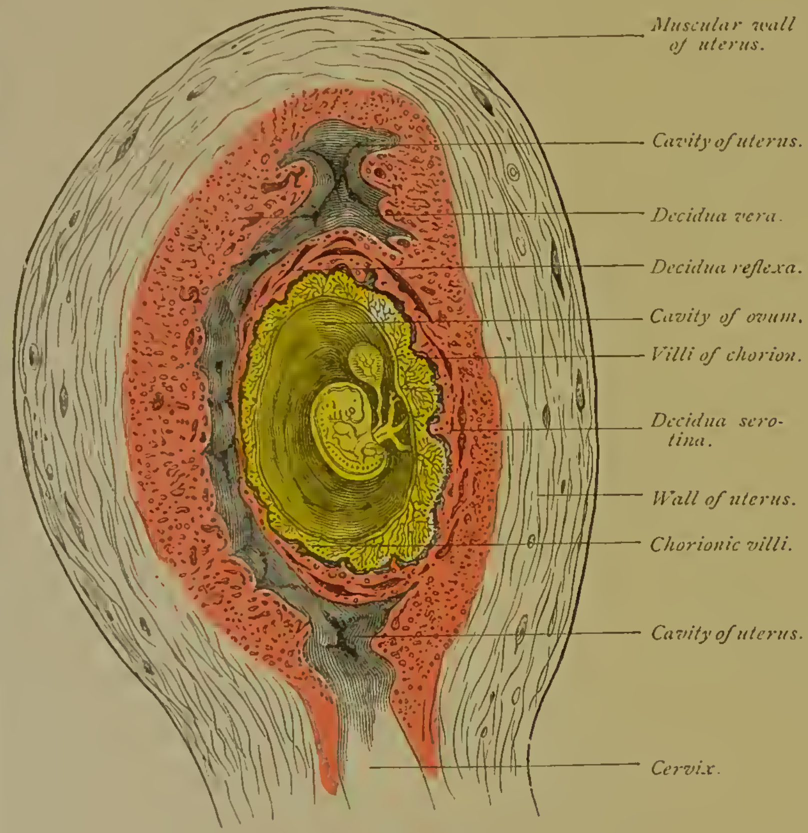
The Placenta and Deciduæ.—The primary uses of mechanical protection afforded by the membranes in mammalian embryos are supplemented by the important *rôle* of assisting in establishing an efficient nutritive organ through which the maternal tissues may extend the necessary aid to the maintenance of the developing animal during the latter two-thirds of its intra-uterine life. Such organ is the placenta, in whose production both fetal and maternal structures take an active part.

The early villi of the chorion are practically identical in all parts where developed. Very soon, however, the villi occupying the area which later will correspond with that of the placenta exhibit unusual growth, and outstrip in size and vigor those of the remaining parts of the envelope. This difference in the development of the villi marks the division of the membrane into the *chorion frondosum* and the *chorion læve*, the former being that part of the chorion which contributes the fetal portion of the placenta (Fig. 76). The villi of the chorion læve undergo gradual atrophy and finally disappear.

The fertilized ovum on reaching the uterus, after descending the oviduct, becomes entangled and retained within the folds of the soft, thickened mucous membrane prepared for its reception. Immediately after its lodgement, which is usually in the vicinity of the fundus, the uterine mucosa takes steps to secure the imprisonment of the ovum by means of a circular fold which gradually rises around the egg until it is completely enclosed within the new envelope formed by the reflected uterine tissue.

In view of the fact that the mucosa of the uterus is discarded at the close of labor, the thickened uterine lining is appropriately termed the *decidua;* of this membrane three regions are recognized: the *decidua reflexa,* or that portion which encloses the ovum by the reflected folds; the *decidua vera,* or that portion which constitutes the greater part of the general lining of the uterine cavity; and the *decidua serotina,* or that portion of the uterine lining included within the embryonic sac completed by the reflexa (Fig. 76; Pl. 13). The decidua serotina derives especial significance from the fact that it contributes the maternal part in the formation of the placenta.

The changes affecting the maternal tissues consist primarily in proliferation of the epithelium and the glands, the latter becoming greatly enlarged both in



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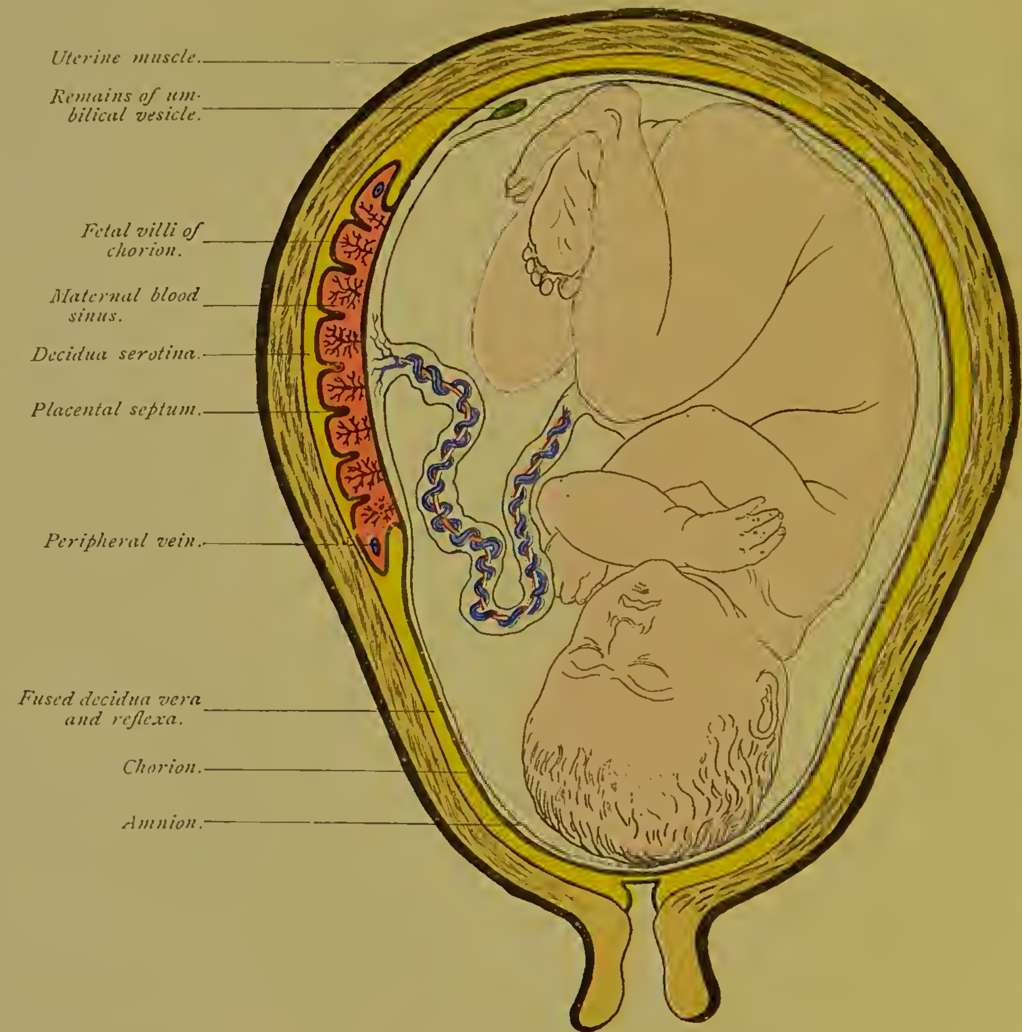

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1. Semi-diagrammatic section of gravid uterus, showing contained ovum of about five weeks (modified from Allen Thompson). 2. Semi-diagrammatic section of uterus, showing relations of fetal and maternal placenta (Ahlfeld).

size and in the number of the tubules, the increase particularly involving their deeper parts. Subsequently the pressure exerted upon this hypertrophied tissue by the rapidly growing embryo and its surrounding structures induces atrophy and degeneration, so that the outermost part of the thickened uterine mucosa becomes the *stratum compactum,* and the middle part the *stratum spongiosum* (Fig. 77). The limited zone embracing the fundi of the tubular uterine glands remains unaffected, and, after the expulsion of the structures

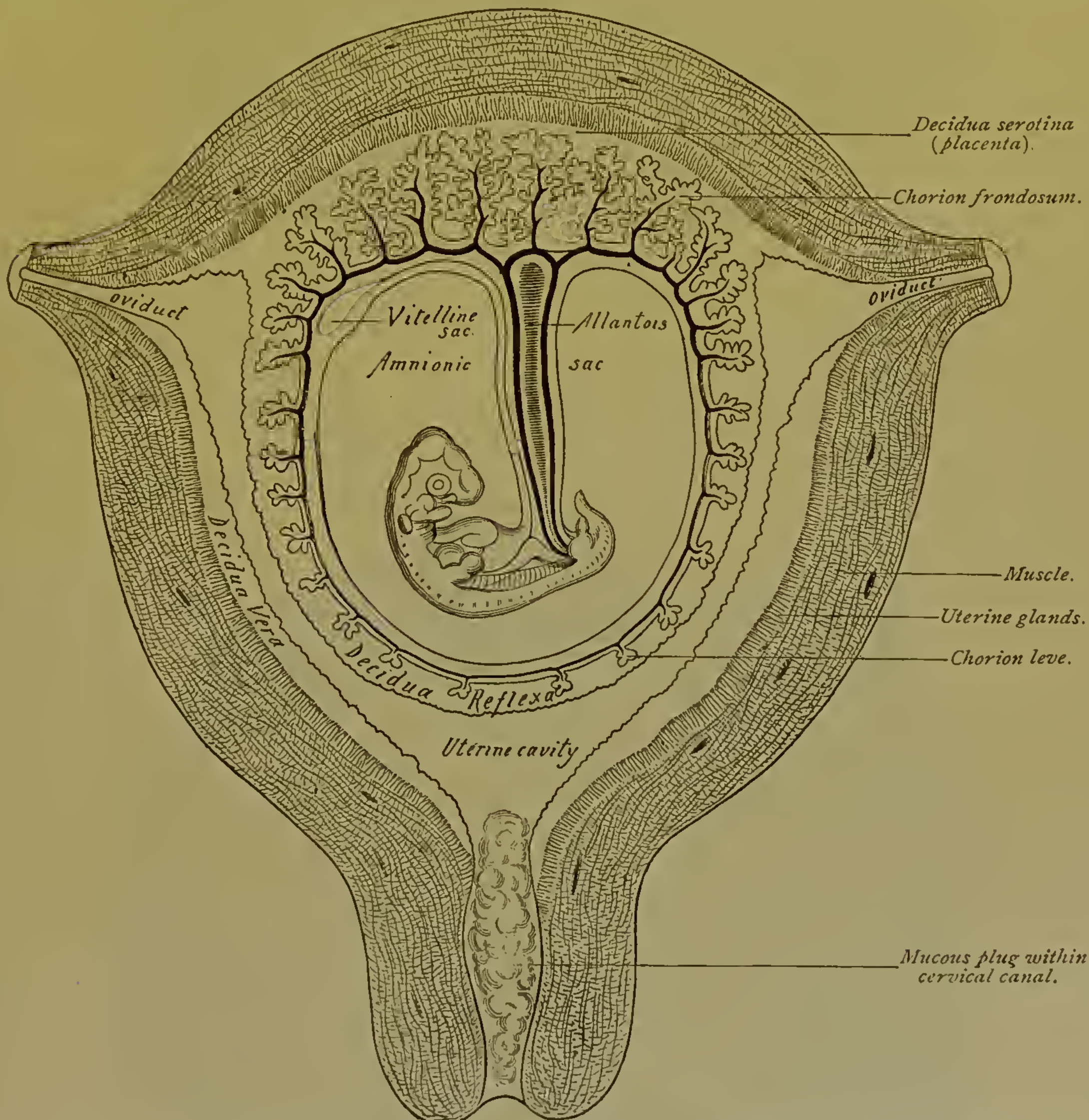


FIG. 76.—Diagram illustrating relations of structures of the human uterus at the end of the seventh week of pregnancy (modified from Allen Thompson).

constituting the after-birth, institutes the processes of repair by which the new mucous membrane of the uterus is produced. As the result of the secondary degeneration of the epithelial portions of the uterine mucosa the vascular chorionic villi are brought into close relations with the vascular connective tissue of the uterus, by which the interchanges between the fetal and maternal circulations are facilitated.

The relations between the fetal and the maternal parts of the placenta, in the simplest type such as possessed by the hog, consist essentially in the recep-

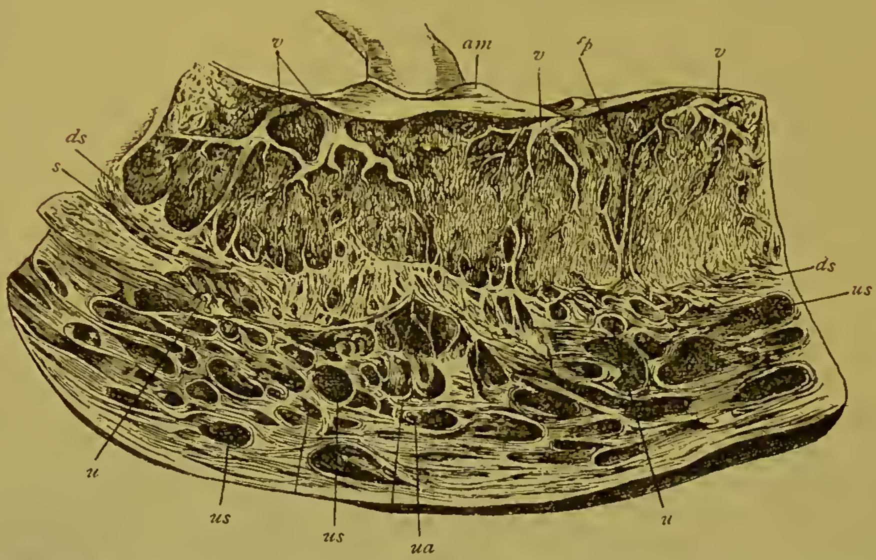


FIG. 77.—Section through uterine wall and attached placenta (Wagner): *u*, uterine wall rendered spongy by greatly-developed uterine sinuses (*us*); *ua*, branches of uterine artery; *ds*, decidua serotina; *s*, line of separation; *fp*, fetal portion of placenta, consisting of a mass of vascular fetal villi (*v.v.v.*), surrounded by the maternal blood-sinuses; *am*, amnion covering free internal surface of placenta.

tion of the simple chorionic villi within corresponding depressions in the

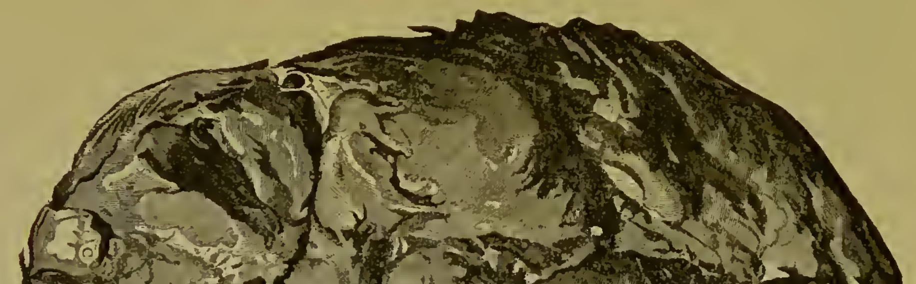
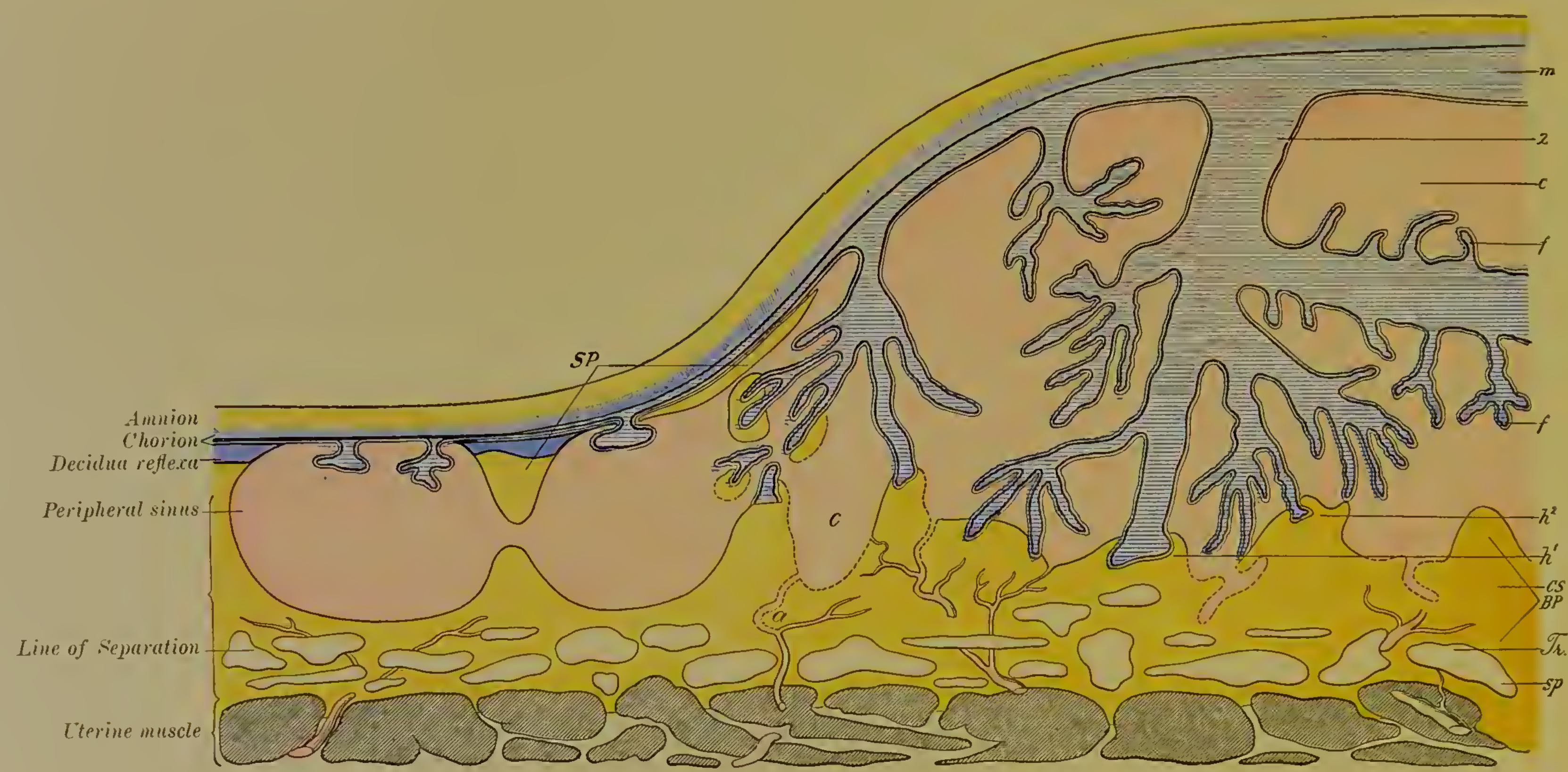


FIG. 78.—Placenta viewed from uterine surface of attachment, showing divisions into cotyledons (Bidloo).

maternal tissues, the circulation of the villi coming into close approximation



Diagrammatic section through the human placenta at the middle of the fifth month (after Leopold): the fetal placenta, consisting of the chorion (*m*) with its villi (*z*), has grown into the maternal placenta; the villi present attached points (h^1, h^2) and free processes (*f*); *SP* is the spongy layer of the decidua serotina, in which the separation takes place along the line *Tr*; *CS* is the compact layer forming inner part of uterine placenta, which consists of the basal plate (*BP*), the closing plate (*sp*), the arteries (*a*), the cavernous blood-spaces (*c*), and the marginal sinus.

with the enlarged blood-vessels of the mother. These simple relations become complicated in the higher mammals and in man by the complex character of the chorionic villi, whose irregular form and disposition are further masked by actual attachments formed between the tips of many large villi and the maternal tissue (Pl. 14).

The disappearance of the epithelial portions of the uterine mucosa brings the fetal villi into close relation with the proliferated connective tissue of the mucosa, with a diminution in the structures separating the fetal and the

FIG. 79.—Placenta at full term, showing superficial distribution of blood-vessels (Minot).

maternal circulation. Coincidently with the changes affecting the decidua serotina, the capillary blood-vessels of this part of the uterine mucous membrane undergo enormous expansion, so that finally they are converted into the large and conspicuous blood-spaces occupying the intervals between the attached chorionic villi and the adjacent maternal tissue. These intervillous blood-spaces, the enormously dilated maternal capillaries, are supplied by arterial twigs and are drained by corresponding venous trunks connected with the larger uterine vessels. Notwithstanding the attachment of many large villi, the greater number, comprised by the smaller villi, are not so bound down, their free ends floating within the large lakes of maternal blood, from which they are separated by the attenuated and atrophic endothelial wall of the space alone.

The human placenta at full term, as seen after the expulsion of the after-birth, is a discoidal mass, usually oval, sometimes circular, but often irregular in outline, about 18 centimeters in diameter and 2.5 to 3 centimeters in thickness. It presents an inner smooth surface, covered by the amnion and looking toward the fetus, and an outer rough, spongy, uterine surface of attachment subdivided by furrows into numerous more or less distinct areas or *cotyledons* (Fig. 78) composed of the lacerated decidual tissue and vessels torn through at the time of the separation of the placenta, the decidua serotina splitting, one part adhering to the outer surface of the placenta, the other remaining attached to the uterine wall. In contrast with the dark blood-clot hue of this tissue, the smooth, shining amniotic surface appears of a generally lighter, somewhat mottled tint, made up of reddish-gray patches alternating with yellowish areas, which depend respectively upon the contained blood and the fetal villi, whose colors shine through the superimposed transparent amnion.

The placental blood-vessels (Fig. 79)—the two umbilical arteries and the single umbilical vein—spread out in all directions from the usually eccentric point of insertion of the umbilical cord, when distended with blood their courses being readily traced both by sight and by touch beneath the overlying amnion. The arterial twigs are more superficial than the veins, which are considerably larger in diameter. Both sets of vessels pass from the smaller to the larger twigs without anastomoses.

Structure.—If the freshly-cut surface of the thickness of the placenta be carefully examined with the unaided eye or with a low magnifying glass, the entire organ is seen to be composed of an inner and an outer membranous boundary, between which is included a thick spongy layer contributing almost the entire thickness of the organ. Closer investigation shows that the spongy layer is composed of the loosely held masses of chorionic villi (Fig. 80), with the intervillous blood-spaces, separated into the cotyledonous areas by connective-tissue septa. The outer membranous boundary consists of the condensed portion of the decidua serotina, which adheres to the fetal villi and supplies the outer wall to the blood-spaces; the inner boundary includes the denser portion of the chorion together with the adherent amnion.

FIG. 80.—Portion of injected villus from a placenta of about five months (Minot).

Microscopic examination of the spongy placental tissue, as seen in sections

(Figs. 81, 82), shows the villi, although differing greatly in size, to be made

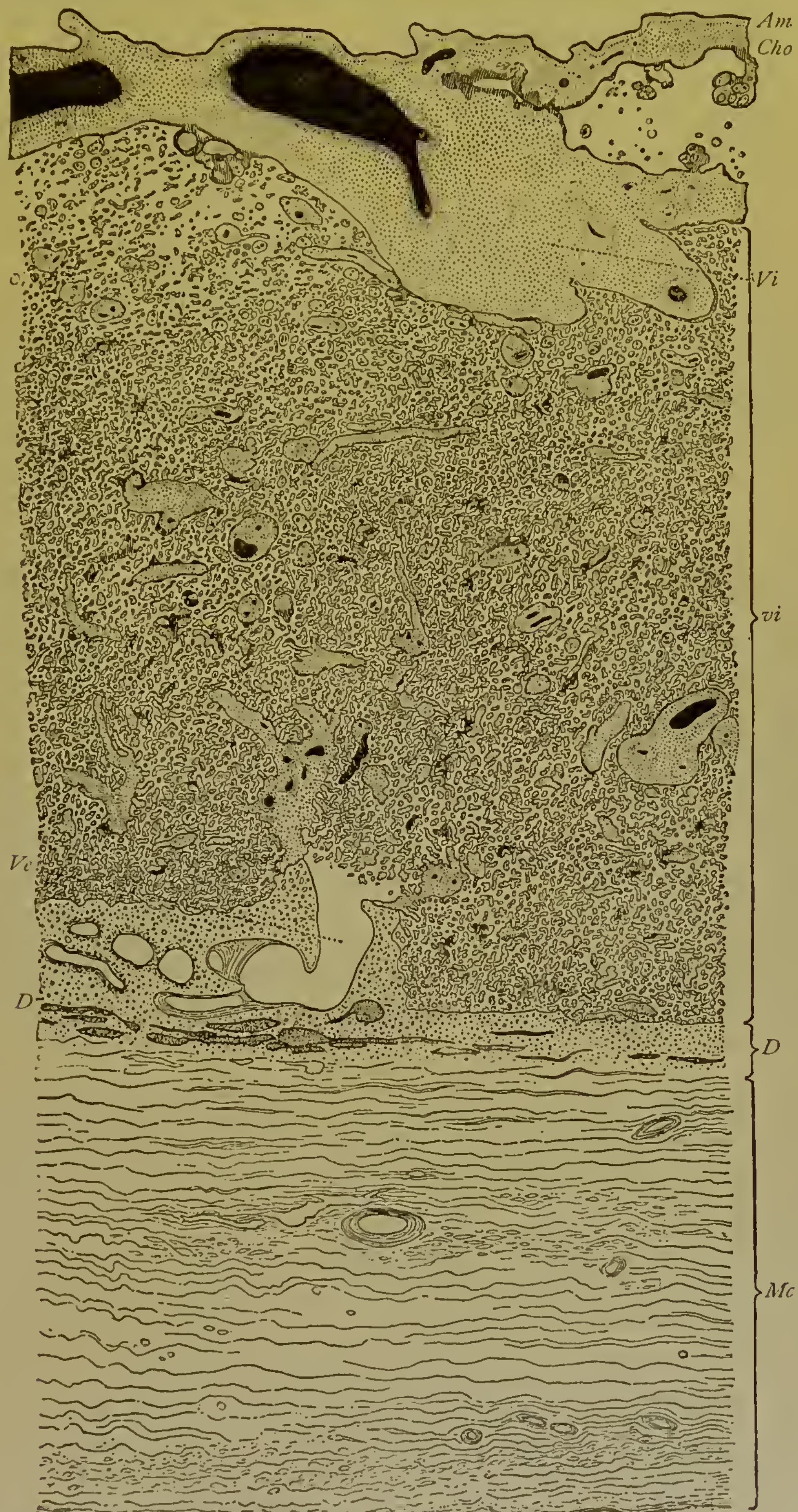


FIG. 81.—Section through placenta of seven months *in situ* (Minot): *Am*, amnion; *Cho*, chorion; *Vi*, root of a villus; *vi*, sections of ramifications of the villi among the maternal blood-spaces; *D*, deep layer of the decidua, showing remains of enlarged glands of stratum spongiosum; *Vc*, uterine blood-vessel connected with placental sinus; *Mc*, muscular wall of uterus.

up of a stroma of embryonal connective tissue containing large branched cells and blood-vessels; these latter consist of the larger twigs, encased by the robust primary stalks, and of all gradations of size to the slender capillary loops supplying the terminal petal-like processes. The exterior of the very young villi is covered by a layer of chorionic epithelium, but this soon becomes less distinct, and after the fourth month it no longer constitutes a continuous layer, but is present only in patches. The ectodermic epithelium covering the cho-

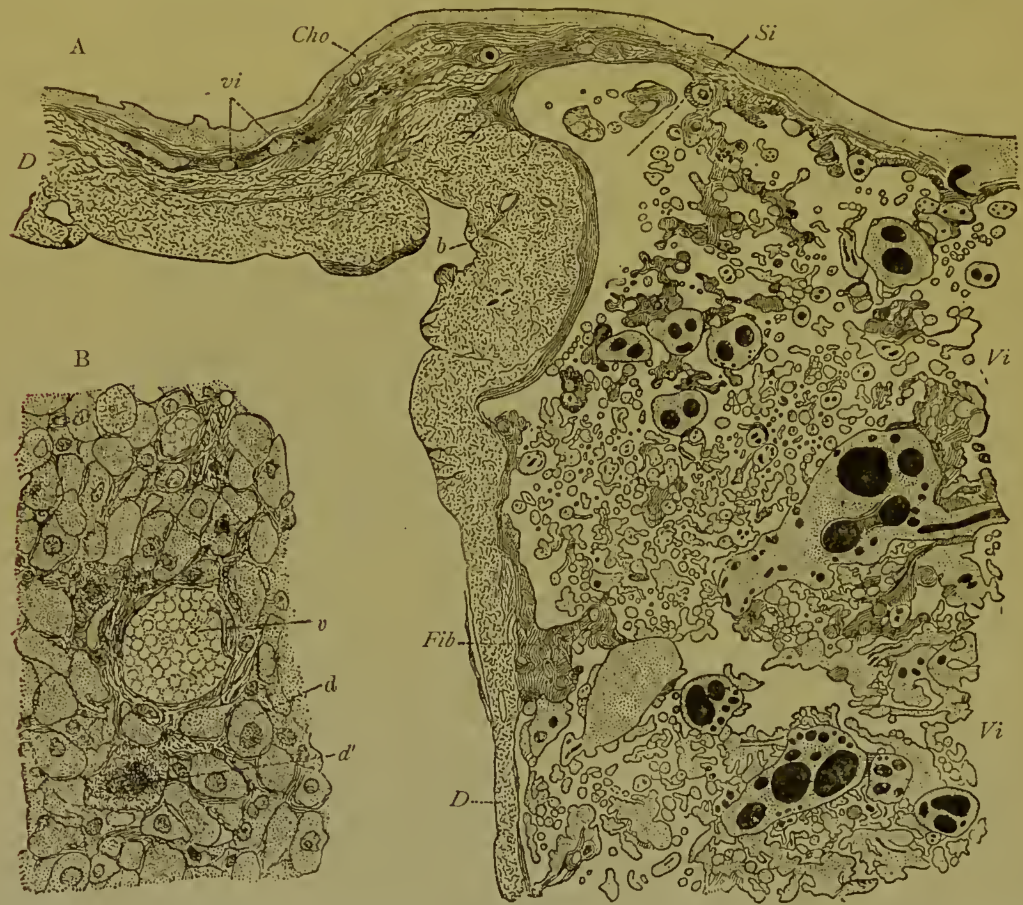


FIG. 82.—A, section through margin of placenta at full term (Minot): *D, D*, deep layer of decidua; *Vi*, chorionic villi variously cut, blood-vessels injected; *Si*, margiual space nearly free from villi; *vi*, atrophic extra-placental villi; *Cho*, chorion; *b*, vessel of uterine wall; *Fib*, canalized fibrine derived from modified chorionic ectoderm. B, decidual tissue from placenta at full term: *d, d'*, decidual cells; *v*, blood-vessel.

rion, as described by Langhans, Kastschenko, and Minot, consists of a deep and a superficial stratum, the cells of the latter assuming a flattened, scale-like form.

Sections of the placenta during the later months of gestation fail to reveal any definite endothelial partition between the exterior of the villi and the maternal blood-spaces, the villi seemingly coming directly in contact with the blood of the mother. The determination of the existence or absence of a distinct wall to the blood-space has given rise to much discussion and conflicting assertion. The solution of the question, as so often is the case, seems to be found in the more careful study of the development of the tissues, which study has shown that in the earliest stages the fetal villi are separated from the maternal blood-vessels by an intervening layer of decidua as well as by the endothelium of the vessels. With the progressively increasing capacity of the enormously dilated blood-capillaries into the blood-spaces the compression and atrophy of the interposed structures follow—first of the decidual tissues, and finally of the vascular endothelium, during the later months of pregnancy the external surface of the chorion and its villi constituting the immediate wall of the maternal blood-space.

4. **Umbilical Cord.**—The formation of the human umbilical cord is closely related to the primary abdominal stalk. The latter, as already noted, may be regarded as the extension of the embryo—as a sort of pedicle connecting its caudal parts with the chorion and containing the allantoic diverticulum. In the early stages the somatic folds which form the amnion bear the same relation to the abdominal stalk as they do to the more anterior parts of the embryo; later they bend around the stalk to meet and join on its ventral surface, the amnion in consequence becoming separated from the stalk, which thus becomes gradually enclosed within a tubular amniotic sheath. The closure of the somatopleuric folds around the abdominal stalk imprisons the umbilical or vitelline duct within a space which is, in fact, part of the celom. This space soon becomes greatly reduced, and finally is obliterated. The foregoing relations point out the fact, strongly emphasized by Minot, that the umbilical cord is covered with the direct extension of the embryonic somatopleure, and not with the amnion, as is often asserted, since the amnion gradually becomes separated from the embryo along the cord as far as its distal end, where it still remains connected.

The most important constituents of the umbilical cord in its earlier condition are the two umbilical arteries, the two umbilical veins, the allantoic diverticulum, and the extension of the celom containing the vitelline duct and, possibly, traces of the vitelline vessels. Later, the umbilical veins fuse and constitute a single vessel; the allantoic lumen and the celomic space atrophy and disappear. The atrophic vitelline or umbilical duct long remains, even after birth the vesicle and its duct appearing as a minute sac and stalk lying between the amnion and the chorion, in close proximity to the placenta.

The human umbilical cord at birth measures about 55 centimeters (22 inches) in length, with from 15 to 160 centimeters (6 to 64 inches) as the extremes of its variations; its diameter is from 10 to 15 millimeters ($\frac{3}{8}$ to $\frac{5}{8}$ inch). The cord usually joins the inner smooth surface of the placenta eccentrically, its insertion at times being marginal, or, in rarer cases, even altogether outside the immediate area of the placenta. The apparent twisted condition of the cord is often very marked, the spirals, sometimes to the number of thirty or more, being emphasized by the contained blood-vessels. While this phenomenon has long been known, a satisfactory explanation of the twisted appearance, which begins before the third month, still remains to be given, notwithstanding numerous theories and discussions. A point of especial interest, as pointed out by Minot, is that there is no evidence that the entire cord really undergoes torsion, but rather that the blood-vessels become coiled within the soft tissue as the result of an excessive unequal growth still insufficiently understood.

The *structure* of the cord includes an external covering of epithelium directly continuous at its distal end with that of the amnion. The bulk of the cord consists of the peculiar form of embryonal connective tissue known as the *jelly of Wharton*, rich in branched cells with anastomosing protoplasmic processes. Shortly beyond the umbilical opening both capillaries and nerves are apparently wanting; lymphatics, in the sense of definite canals, are also absent. In addition to the large umbilical blood-vessels, epithelial masses indicate the remains of the allantoic diverticulum and the vitelline duct.

5. **Development of the External Form.**—Adopting the divisions suggested by His, it is convenient to distinguish three stages in the development of the human subject. The *stage of the ovum* embraces the first two weeks of gestation, and is occupied by the earliest developmental processes; the *embryonal stage* includes from the third to the fifth week, during which time the characteristic embryonal features are pronounced and the principal organs and symptoms are well established; the remaining weeks of pregnancy are devoted to the *fetal stage*, during which the embryonal characters are gradually replaced by those of the fetus and the full-term child. While it is evident that no sharp demarcation separates these stages, yet certain well-pronounced characteristics distinguish, in general at least, embryos of particular developmental epochs, and consequently serve to determine their probable age notwithstanding individual variation.

Stage of the Ovum.—Opportunities for examining early human ova are rare, the youngest well-authenticated and carefully-observed specimen being the classical ovum of about twelve days described by Reichert (Fig. 83). The

FIG. 83.—Human ovum of about twelve days (Reichert): A, front view; B, side view. The villi are seen to be limited in distribution, leaving the poles free.

appearance of this ovum emphasizes the early and precocious development of the villi which encircle the flattened lenticular vesicle (5.5 millimeters in its greatest diameter by 3.3 millimeters in thickness) as a closely set equatorial zone. Of the embryo proper no trace was discoverable, a patch of thickened cells alone representing the embryonal area. The earlier processes of segmentation and blastulation have never been observed in the human ovum.

Stage of the Embryo.—The thirteenth and fourteenth days witness the evolution of the early embryonal form as effected by the development of the medullary groove and canal and their cephalic expansion. The embryo is attached by the allantoic stalk to the surrounding membranes, the axes of the stalk and the upright embryo generally coinciding (Figs. 84, 85; see also Fig. 97); what flexure exists at this time is backward, and results in a concave dorsal outline. The ventral aspect of the embryo of this stage is largely occupied by the relatively huge vitelline sac, which freely communicates with the imperfectly defined gut along almost the entire length of the embryo. The precociously developed amnion has completely enveloped the embryo and its stalk as far as the distal attachments of the latter. The heart is first represented by two longitudinal folds corresponding with the primary halves from which

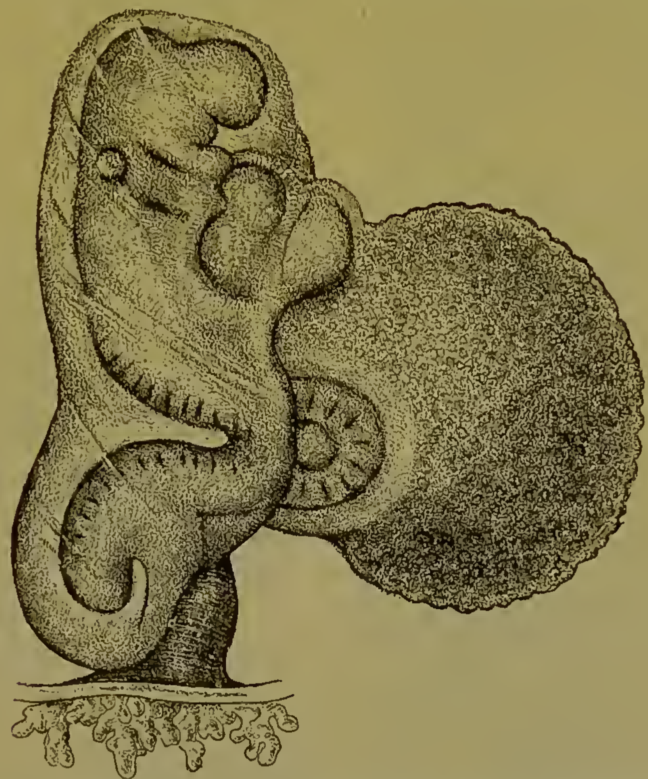


FIG. 84.—Human embryo of about the fifteenth day (His): the embryo is attached to the wall of the blastodermic vesicle by means of the umbilical or allantoic stalk, and is enclosed within the amnion; the large vitelline sac freely communicates with the still widely open gut.

the organ is formed; slightly later, these folds fuse into a single heart, which then appears as a conspicuous projection between the yolk-sac and the cephalic vesicle.

The third week (Fig. 86) is productive of many important additions to the exterior of the embryo. Its form becomes more definite; the brain-vesicles, together with the optic vesicles and the auditory sacs, are differentiated; the visceral arches and the corresponding furrows are formed; the yolk-sac is much more constricted, and its narrower connection with the gut foreshadows the later vitelline stalk. By the twenty-first day the first rudiments of the limbs appear.

The fourth week (Fig. 86) is marked by great increase in size and by conspicuous changes which give to embryos of this age distinctive features, growth being relatively more active at this period than at any other. With the termination of the third week the embryo is still erect. During the next day flexion takes place with great rapidity, so that during the twenty-third day the cephalic and caudal poles of the embryo actually meet or even overlap, the dorsal outline approximating a circle (Figs. 86, 87). The individual brain-vesicles are better developed, as are also the visceral arches and furrows, the eyes, ears, and nose; the heart has increased in size, and the limb-buds have become more pronounced. At the end of the twenty-third day extreme flexion has taken place, from which time until the close of the fourth week the embryo gradually becomes less tightly coiled on itself, the larger and more conspicuous head slowly rising and leaving the tail.

During the latter half of the fourth week, in addition to the increased development of the visceral arches, the individual cephalic flexures become

FIG. 85.—Human embryo of about the thirteenth day (His): the caudal pole of the embryo is connected with the blastodermic vesicle by means of the abdominal or allantoic stalk; the amnion already completely encloses the embryo, and the large vitelline sac communicates throughout the greater part of the mitral surface by means of the unclosed gut-tract.

very conspicuous. These flexures consist of a sharp bending of the anterior parts of the head upon the posterior half, resulting in a change of nearly 90° in the cephalic axis, with the production of a conspicuous prominence marking the position of the mid-brain. Posteriorly, the cervical flexure sharply indicates the junction of the cephalic and trunk segments; farther caudally, the dorsal and coccygeal flexures mark less pronounced changes in the direction of the embryonic axis. On either side of the dorsal mid-line, extending from the cervical flexure to the tip of the caudal extremity, a series of prominent quadrilateral areas indicate the position of the somites or provertebræ (Fig. 86, 11 and 12).

The development of the *visceral arches* reaches its highest expression by the termination of the fourth week, when the series of arches is seen in its best condition (see Fig. 129). In man and in mammals five arches are successively developed from before backward, the last, however, being scarcely differentiated and very inconspicuous. The first arch when fully formed is partially divided into an upper and a lower secondary division, the *maxillary* and *mandibular processes,*

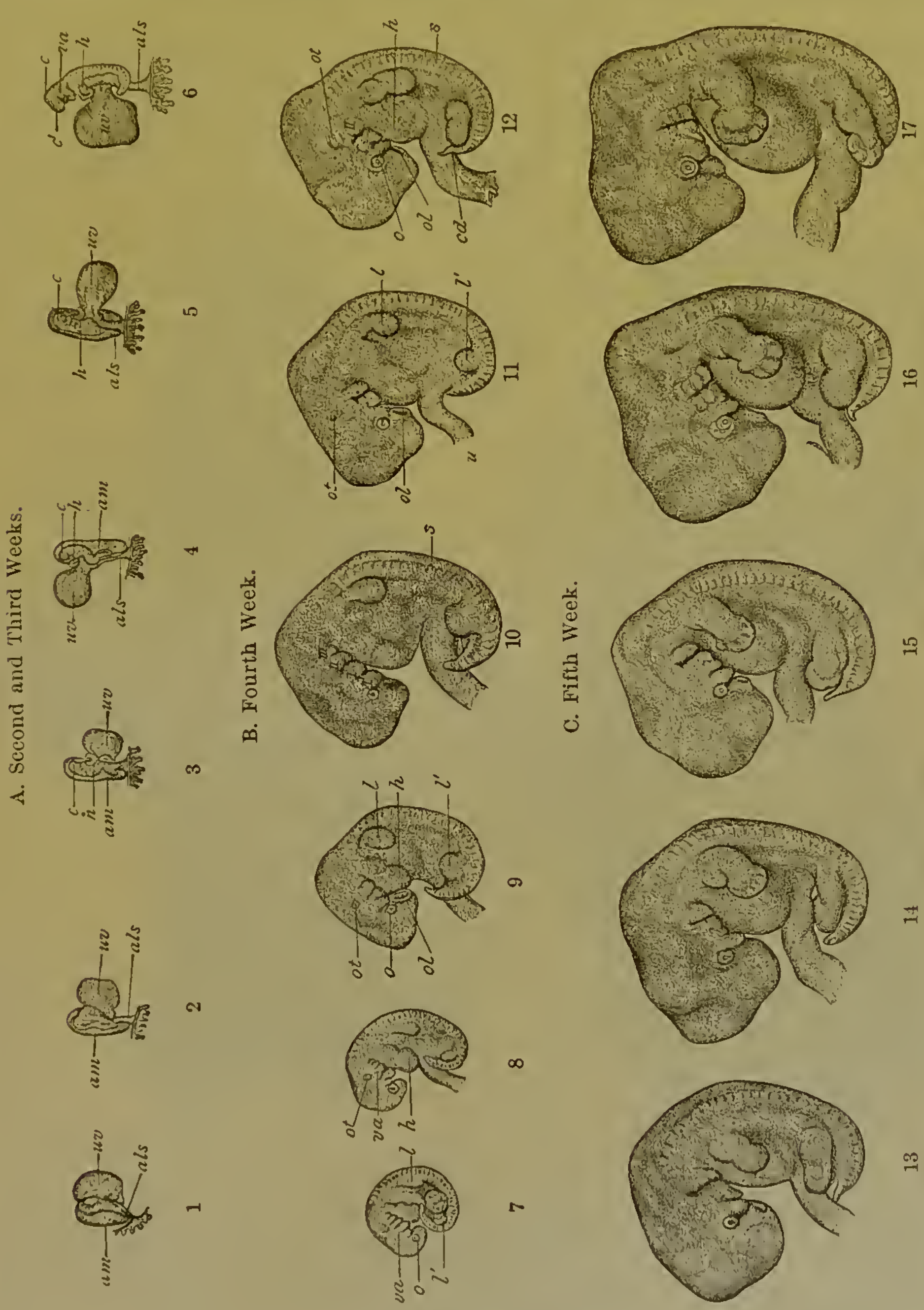


Fig. 86.—Early human embryos, all enlarged about two and a half times (His): 1–4, from twelfth to fifteenth day; 5, 6, from eighteenth to twenty-first day; 7, 8, from twenty-third to twenty-fifth day; 9–12, from twenty-seventh to thirtieth day; 13–17, from thirty-first to thirty-fourth day. *am*, amnion; *uv*, umbilical or vitelline vesicle; *als*, allantoic or abdominal stalk; *c*, *c'*, brain-vesicles; *h*, heart; *va*, visceral arches; *o*, optic vesicle; *ot*, otic vesicle; *ol*, olfactory pit; *l*, *l'*, upper and lower extremities; *s*, somites; *cd*, caudal process; *u*, primitive umbilical cord.

so called from the parts to whose construction they respectively largely contribute. The maxillary processes of the first arch, in connection with the intervening *naso-frontal process,* contribute the parts which eventually become the upper boundaries of the oral cavity; the mandibular processes of the same arch join to form the lower boundary of the mouth. During the fifth week the margins of the centrally projecting naso-frontal plate differentiate into two secondary processes, the *processus globulares,* forming the inner borders of the nasal pits, and the *lateral frontal processes,* which contribute the outer wall of the nasal fossæ and separate these depressions from the eyes. These processes normally unite to form the continuous structures around the nose and the mouth.

Faulty union or imperfect closure of the intervening fissures gives rise to the varieties of hare-lip and cleft palate and to other forms of congenital facial defects. The *second* or *hyoid arch,* as well as the third, fourth, and fifth arches, eventually fuses with its neighbors and loses its identity; a similar fate awaits the intervening outer visceral furrows or "clefts," with the excep-

FIG. 87.—Development of the face of the human embryo (His): A, embryo of about twenty-nine days. The naso-frontal plate differentiating into processus globulares, toward which the maxillary processes of first visceral arch are extending. B, embryo of about thirty-four days: the globular, lateral, frontal, and maxillary processes are in apposition; the primitive opening is now better defined. C, embryo of about the eighth week: immediate boundaries of mouth are more definite and the nasal orifices are partly formed, external ear appearing. D, embryo at end of second month.

tion of the first, since they gradually become obliterated by the fusion of the surrounding arches. The first outer furrow, or *hyomandibular cleft,* contributes largely to the formation of the external auditory canal, while the surrounding portions of the mandibular and hyoid arches contribute the tissue from which the external ear is derived.

The Second Month.—The fifth and sixth weeks (Figs. 86, 88) add to the size and the general advanced development, although the phenomenal rate of growth of the preceding week is replaced by more gradual increase. The limbs constitute the most characteristic features of this period, since what prior to the fifth week were but rudimentary limb-buds now undergo differentiation into distinct segments, at first two, then three. Toward the close of the fifth week the flattened terminal segments representing the future hands and feet exhibit distinctions as thin marginal plates and thicker proximal portions. The marginal areas very soon exhibit traces of the digits as small elevations separated by shallow grooves which gradually extend toward the free ends. The fore limbs appear slightly earlier than the hind limbs, and retain this lead throughout their development. By the middle of the sixth week the fingers are sufficiently developed to project beyond the hand, although the toes are just beginning to be outlined, and represent a stage of ten to fourteen days later. Coincidently with these changes the general development of the embryo has steadily progressed (Fig. 89), with the result of supplanting the embryonal characteristics by those of distinctly fetal type. The head, though proportionately large, has become partially once more raised; the boundaries of the mouth have become definitely located; the external parts of the eye, the ear, and the nose are well advanced; and the general contour of the trunk has assumed more of the characters of the child.

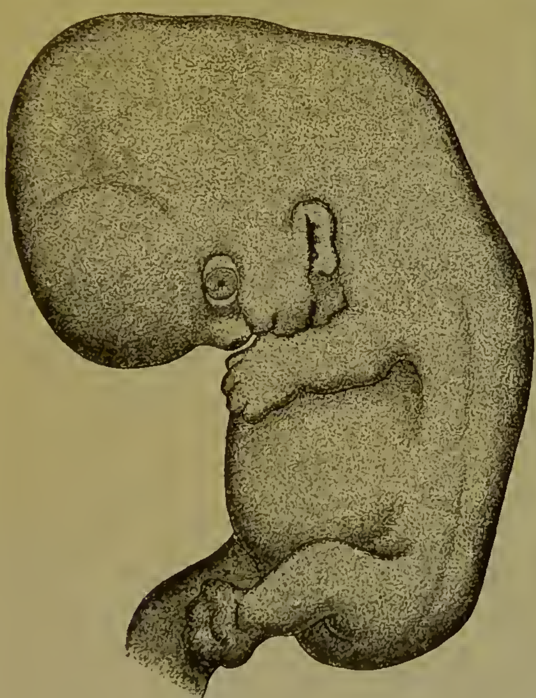


FIG. 88.—Human embryo of about six weeks, enlarged five times (His).

FIG. 89.—Human embryo of about seven weeks, enlarged five times (His).

The second month witnesses the disappearance of the cervical flexion and the further lifting of the head, which is still very large (Fig. 90). The face shows distinct advancement toward its completed type, although the nose is yet unduly broad, and indications of the fissures surrounding the mouth are discernible. The limbs project from the body, and the fingers, including the differentiated thumb, and the toes are well defined. By the close of the second

FIG. 90.—Human embryo of about eight and a half weeks, enlarged five times (His).

month the fetus measures from 25 to 30 millimeters (1 to $1\frac{1}{8}$ inches) in length and weighs from 15 to 20 grams.

The Third Month.—The third month establishes the human form, although the head still unduly preponderates. The limbs have acquired their definite shape, and the imperfect nails are present on both fingers and toes. During this month the external organs of generation become definitely differentiated, although they make their appearance several weeks earlier. At the end of this period the fetus measures about 7 centimeters ($2\frac{3}{4}$ inches) in length and weighs about 120 grams (4 ounces).

The Fourth Month.—Short hairs, devoid of pigment, appear on the scalp and on some other parts of the body, which is now covered with firmer skin of rosy hue. The eyelids, nostrils, and lips are closed. The anus opens, and the coils of intestine, which before extended into the umbilical cord, now lie entirely within the abdominal cavity. The point of emergence of the umbilical cord lies low down, close to the pubes. The head forms about one-fourth of the entire body; the bones of the skull, while ossifying, are still widely separated. The sexual distinctions of the external organs are well defined. At the end of this period the length of the fetus has increased to about 12.5 centimeters (5 inches), and its weight to between 230 and 240 grams ($7\frac{3}{4}$ ounces).

The Fifth Month.—The heart and the liver share with the head in the undue preponderance which these parts present. The contents of the small intestine—the meconium—show traces of bile, being of a pale yellowish-green color. The lower extremities are now longer than the arms; the nails are well formed. Hairs are more plentiful, but are devoid of color. At the termination of this month the fetus measures 20 centimeters (8 inches) in length and weighs about 500 grams (1 pound). The fetal movements are now distinctly felt by the mother.

The Sixth Month.—The surface presents many wrinkles and a dirty-reddish hue; the sebaceous coating, the *vernix caseosa*, begins to appear. This whitish substance is composed of the dead and shed surface-epithelium, mingled with the secretions of the sebaceous glands; its primary function is the protection of the fetal integument from maceration by the amniotic fluid. Eyebrows and eyelashes begin to grow. The length of the fetus by the end of this period has increased to 30 centimeters (12 inches), and its weight to about 1 kilogram or 1000 grams (2 pounds).

The Seventh Month.—The continued deposition of subcutaneous fat causes a general appearance of greater plumpness, although the surface is still somewhat wrinkled; hairs about 5 millimeters ($\frac{3}{16}$ inch) in length; eyelids are now permanently open. The liver is still relatively large; meconium occupies the entire large intestine; the testicles have descended as far as, or even into, the inguinal canals. Children born at the end of this period may survive, although they usually succumb. The fetus now measures about 35 centimeters (14 inches) and weighs about $1\frac{1}{2}$ kilograms (3 pounds).

The Eighth Month.—This and the succeeding month are occupied by increase in bulk rather than by great gain in length. The skin assumes a brighter flesh-color; the scalp is plentifully supplied with hair; the nails almost reach the finger-tips. The *vernix caseosa* forms a complete coating; the lanugo, or embryonal down, begins to disappear. The subcutaneous fat has increased, giving less harsh outlines to the body. The close of this month finds the fetus measuring about 40 centimeters (16 inches) and weighing from 2 to $2\frac{1}{2}$ kilograms (4 to 5 pounds).

The Ninth Month.—The fetus at full term presents usually a well-rounded body, from which the lanugo has almost entirely disappeared. The skin is less highly colored, and is covered in places, particularly the head, the axilla, the groin, and the flexor surfaces, with a layer of protecting *vernix.* Both testicles have descended into the scrotum ; in the female the labia majora are in contact. The intestinal tract contains the dark-greenish-colored *meconium,* consisting of the secretions of the intestines and the liver mixed with the epi-

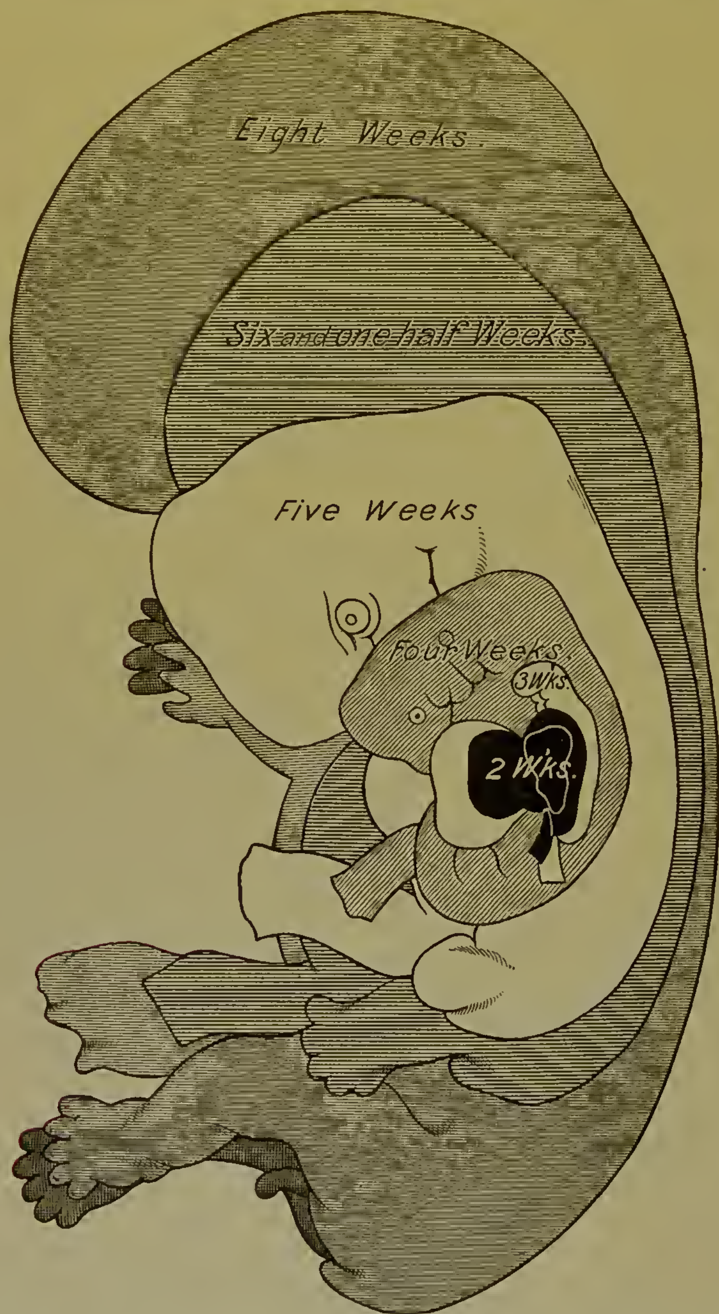


FIG. 91.—Diagram illustrating the outlines of the human fetus at various stages, from the end of the second to the end of the eighth week, magnified five times (modified after Mall).

thelium from the digestive tube, together with epidermis and lanugo swallowed by the fetus. The umbilicus has reached a position almost exactly in the middle of the body. The first epiphyseal ossification to appear, that of the lower end of the femur, is often the only one present, but ossification may have commenced also in the upper epiphyses of the tibia and the humerus.

A convenient simple method of determining the approximate length of the fetus at any period during gestation has been given by Haase. The length in centimeters may roughly be estimated up to the end of the fifth month by *squaring* the month; beyond the end of the fifth month, by *multiplying* the month by the common coefficient 5.

Computed by this method, the approximate greatest or entire lengths of the fetus for the several months are:

At the end of	1 month	the length	= $1 \times 1 =$	1 centimeter	=	$\frac{2}{5}$ inch.
" "	2 months	" "	= $2 \times 2 =$	4 centimeters	=	$1\frac{1}{2}$ inches.
" "	3	" " "	= $3 \times 3 =$	9 "	=	$3\frac{5}{8}$ "
" "	4	" " "	= $4 \times 4 =$	16 "	=	$6\frac{3}{8}$ "
" "	5	" " "	= $5 \times 5 =$	25 "	=	10 "
" "	6	" " "	= $6 \times 5 =$	30 "	=	12 "
" "	7	" " "	= $7 \times 5 =$	35 "	=	14 "
" "	8	" " "	= $8 \times 5 =$	40 "	=	16 "
" "	9	" " "	= $9 \times 5 =$	45 "	=	18 "
" "	10	" " "	= $10 \times 5 =$	50 "	=	20 "

The full-term fetus measures, on an average, about 50 centimeters (20 inches) in its entire length, and weighs from 3 to $3\frac{1}{2}$ kilograms (from 6 to 7 pounds), the average weight for boys being 3340 grams (7 pounds, 6 ounces), and that for girls 3190 grams (7 pounds). The individual variations in weight of new-born children include a wide latitude, as indicated by the extremes of 717 grams (1 pound, $9\frac{1}{4}$ ounces) and 6123 grams (13 pounds, 8 ounces), as accepted by Vierordt. Children really exceeding 5 kilograms (about 10 pounds at birth are very rare, notwithstanding numerous reputed cases. Waller, however, reports a case of a living infant, delivered by him with forceps, that weighed 15 pounds 15 ounces! In addition to sex, boys being heavier than girls, the size of the child is materially influenced by the conditions of maternal parentage; thus: (1) Young mothers have the smallest children, and mothers between thirty and thirty-five years have the heaviest. (2) The weight of the child increases with the number of previous pregnancies, providing that the successive children are of the same sex and that the pregnancies do not follow too rapidly; the children of primiparæ, therefore, average less than those of multiparæ. (3) The weight of the child increases with the weight (Gassner) and the length (Frankenhaüsen) of the mother. In addition, obviously, all causes adversely affecting the physical condition of either parent may exert an unfavorable influence on the vitality and development of the fetus.

6. **Development of the Circulatory System.**—The vascular system is formed by the development of two parts, at first entirely distinct—the extra-embryonic blood-vessels, and the central circulatory apparatus represented by the heart and the great primary trunks. The extra-embryonic blood-vessels constitute successively two distinct systems, the *vitelline* and the *allantoic circulation.* The first of these in mammals and in man is comparatively unimportant; the second is of the utmost importance, since it takes an active part in securing the nourishment of the embryo from the maternal tissues by means of the formation of the placental circulation which it becomes.

Very early in the development of the embryo the germinal area becomes mottled by the appearance at its periphery of an irregular network of branching patches of darker tint than the surrounding tissue, due to the active cell-proliferation. These patches are the *blood-islands of Pander*, so called from the active *rôle* played by them in the production of vascular tissue—vessels and blood-cells. By the extension of the blood-islands and the newly-formed vessels the circulation within the *area vasculosa* (Pl. 15) rapidly extends centrally and toward the embryo, with which communication is later established by the vitelline arteries and veins, large trunks which connect with the cephalic and caudal extremities respectively of the primitive circulatory apparatus which has meanwhile been developed within the embryo. The significance of the vitelline circulation in mammals is probably merely suggestive of its far greater importance in the lower types, where absorption of nutritive materials from the large and conspicuous yolk constitutes an evident reason for its development. In man and in mammals it is doubtful whether the vitelline circulation contributes nutritive substances in any appreciable degree.

Coincidently with the decrease in the yolk-sac and its vitelline circulation, the vessels supplying the allantoic tissues become more prominent, the growth of the two systems proceeding in inverse order. The conversion of a portion of the vascular chorion into the fetal contribution of the placenta advances the importance of these vessels to that of the placental circulation, as first represented by the two umbilical veins and the two umbilical arteries, the latter the direct continuations of the intra-embryonic hypogastric arteries. Later, the two veins fuse within the allantoic stalk, thereby producing a single venous trunk which accompanies the arterial stems. Within the body of the fetus, however, the umbilical veins, which there remain separate, develop unequally, the right suffering atrophy and finally disappearing, while the left increases in size and persists until birth as the important umbilical vein conveying the blood to the liver.

The Heart.—Coincidently with the formation of the primary extra-embryonic blood-vessels within the vascular area, the heart early begins its develop-

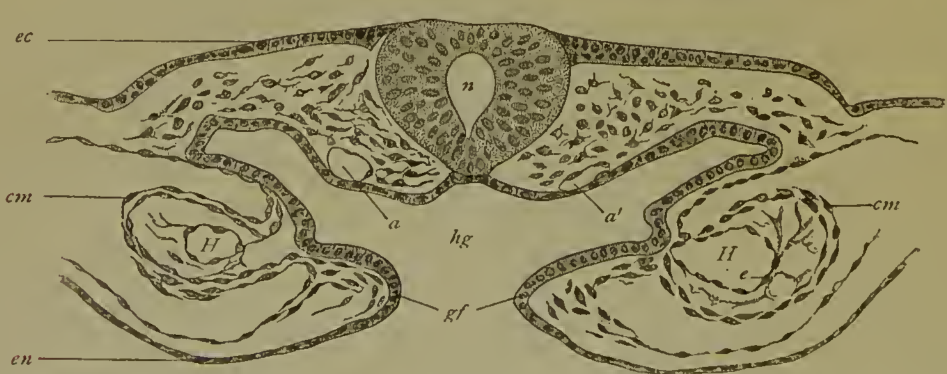
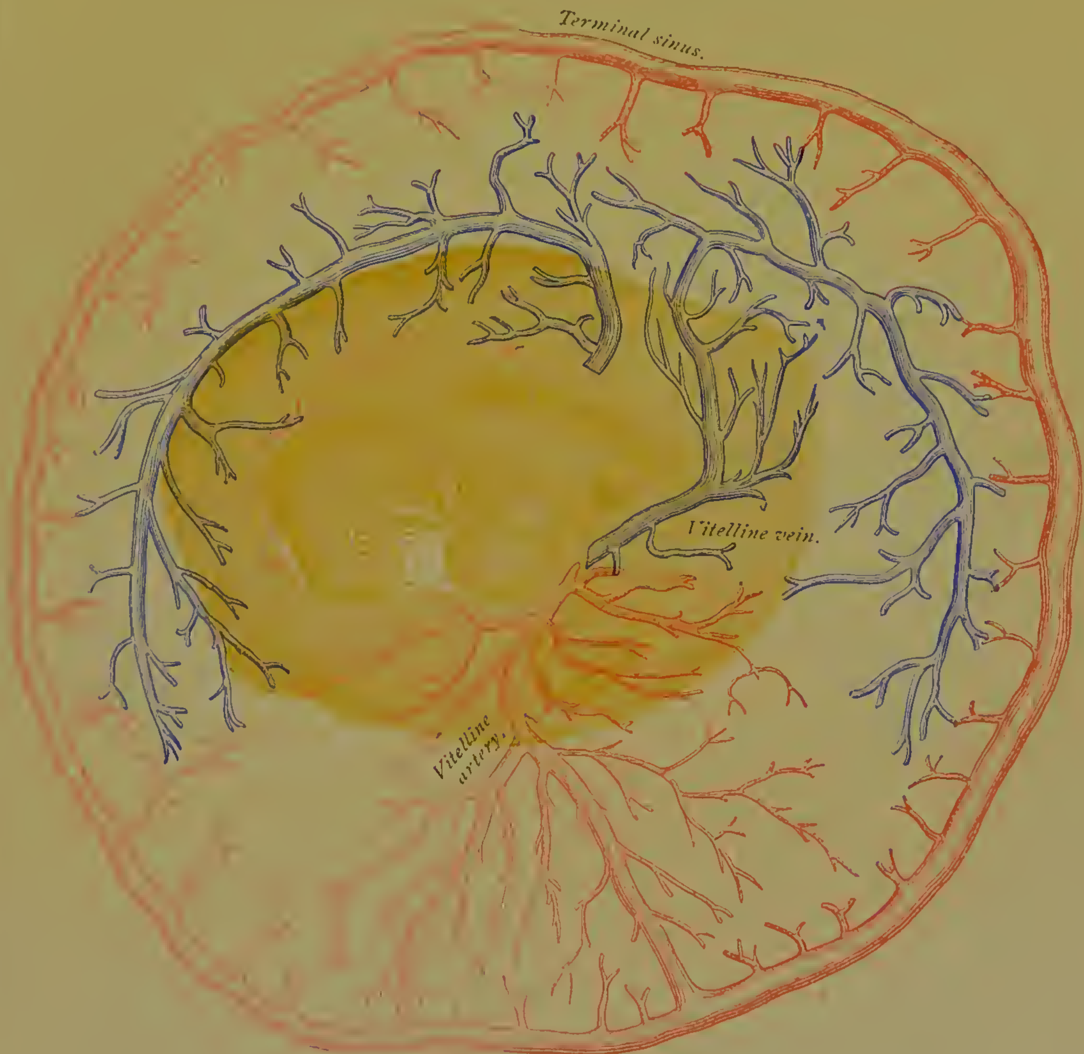


FIG. 92.—Section of early embryo of rabbit (Piersol), showing two separate heart-tubes (*H*, *H*): *c*, primitive endothelium; *cm*, mesoderm forming cardiac wall; *ec*, ectoderm; *en*, entoderm; *gf*, folds producing ventral wall of gut-tract; *hg*, head-gut; *a*, *a'*, primitive aorta; *n*, neural canal.

ment. The first trace of this important organ appears as a folding off and hollowing out of a limited mesodermic area on each side; the two heart-tubes



Vascular area of eleven-day rabbit embryo (E. v. Beneden and Julin): capillaries not shown; the terminal sinus is seen to be arterial.

thus formed lie within the splanchnic mesoderm and are at first widely separated from each other (Fig. 92). With the bending together and approximation of the visceral layers in the formation of the gut-tract the heart-tubes are brought into apposition, and finally fuse, the union resulting in the production

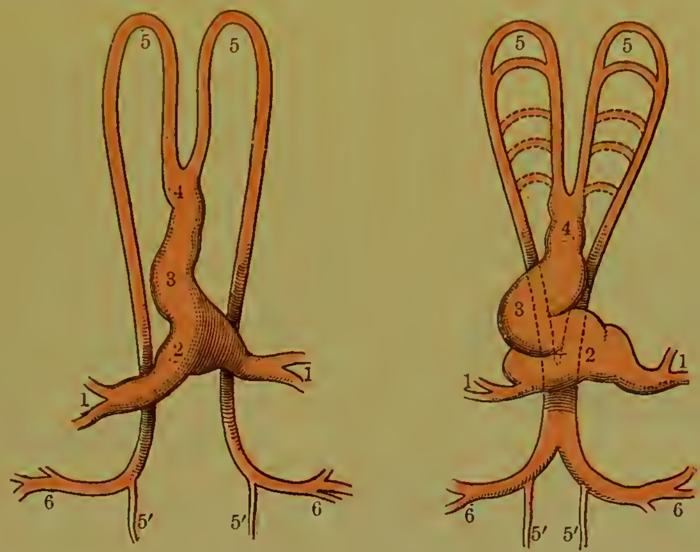


FIG. 93.—Diagrams illustrating arrangement of primitive heart and aortic arches (modified from Allen Thompson): 1, vitelline veins returning blood from vascular area; 2, venous segment of heart-tube; 3, primitive ventricle; 4, truncus arteriosus; 5, 5, upper and lower primitive aortæ; 5′, 5′, continuation of double aortæ as vessels to caudal pole of embryo; 6, vitelline arteries returning blood to vascular area.

of a short, straight receptacle, into the caudal end of which empty the vitelline veins, and from the cephalic extremity pass the primitive arterial trunks (Fig. 93).

This early straight heart-tube, lying attached to the floor of the pharyngeal region, is very transient, since the rapidly increasing length of the organ, its

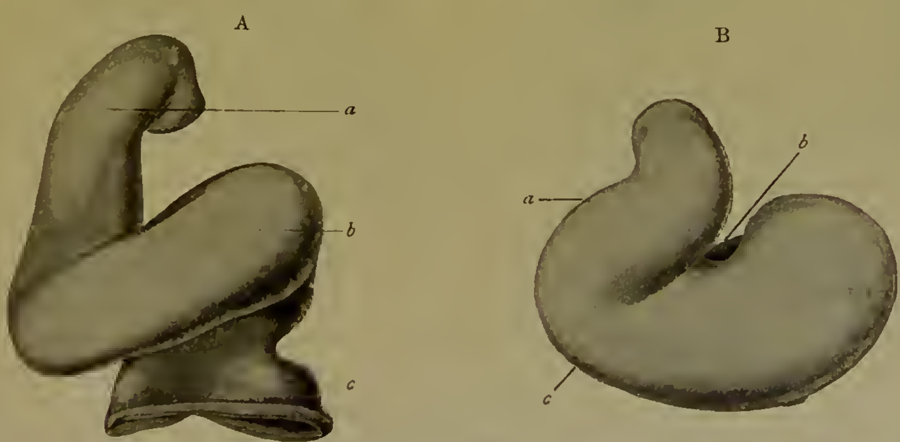


FIG. 94.—A, heart of human embryo of 2.15 mm. (His): *a*, truncus arteriosus; *b*, primitive ventricle; *c*, venous segment. B, heart of human embryo of about 3 mm. (His): *a*, truncus arteriosus; *b*, venous segment (behind); *c*, primitive ventricle (in front).

ends being relatively fixed, soon necessitates flexion, which takes place in both sagittal and transverse planes, and results in giving to the tube the S-form. The lower and posterior limb of the heart receives the great veins and is the *sinus venosus* (Fig. 94); the lower and anteriorly directed loop is the auricular or venous compartment; the upper and posteriorly directed loop is the ventricular or arterial compartment; the upper limb is the *truncus arteriosus*, from which arise the primitive *aortic arches*. The heart, therefore, at this stage—about the fourteenth day—consists essentially of two imperfectly separated

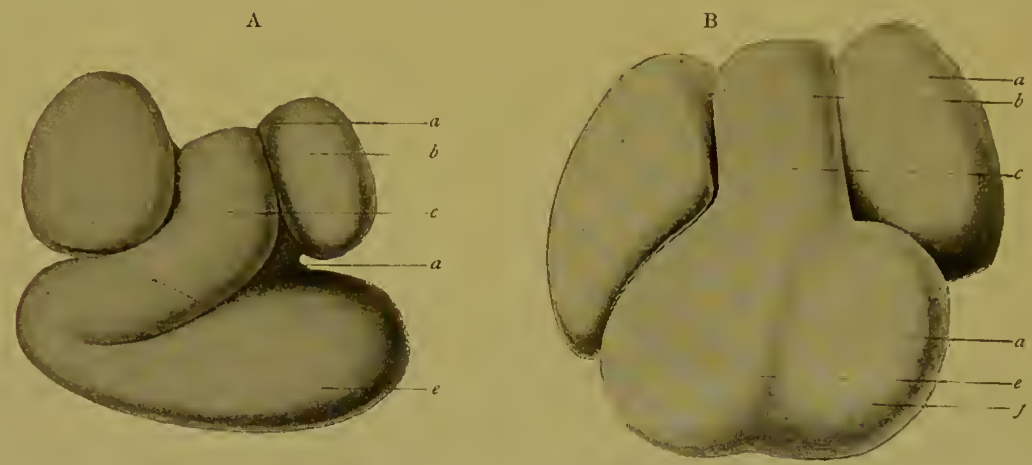


FIG. 95.—A, heart of human embryo of about 4.3 mm. (His): *a*, atrium; *b*, portion of atrium corresponding with auricular appendage; *c*, truncus arteriosus; *d*, auricular canal; *e*, primitive ventricle. B, heart of human embryo of about the fifth week (His): *a*, left auricle; *b*, right auricle; *c*, truncus arteriosus; *d*, interventricular groove; *e*, right ventricle; *f*, left ventricle.

divisions—a lower and posterior venous chamber and an upper and anterior arterial compartment—into and from which pass the larger primitive venous and arterial trunks.

The venous or auricular division during the third week develops two con-

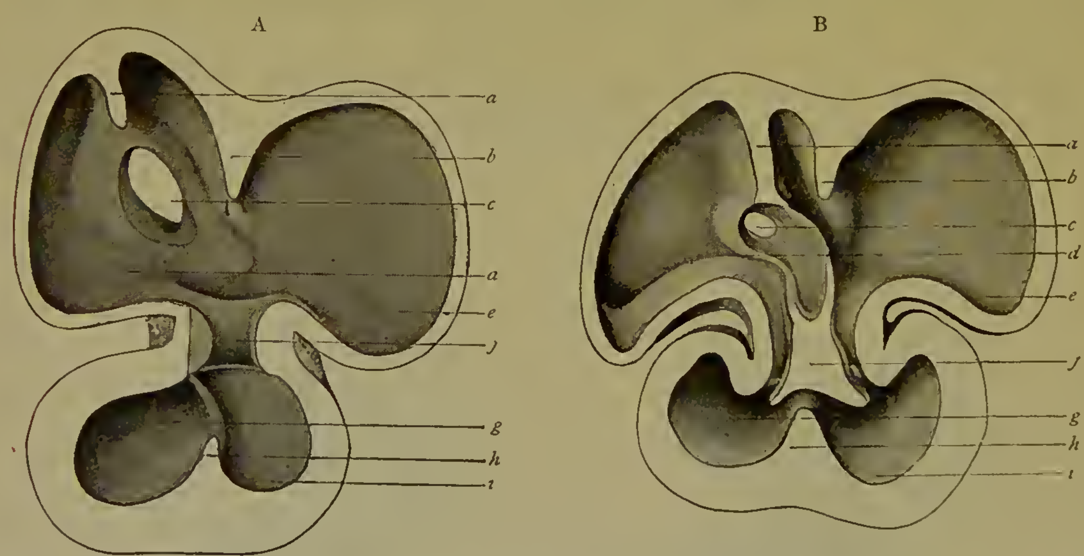


FIG. 96.—A, section of heart of human embryo of 10 mm. (His): *a*, septum spurium; *b*, interauricular septum; *c*, mouth of sinus reuniens; *d*, right auricle; *e*, left auricle; *f*, auricular canal; *g*, right ventricle; *h*, interventricular septum; *i*, left ventricle. B, section of heart of human embryo of about the fifth week (His): *a*, septum spurium; *b*, auricular septum; *c*, opening of sinus reuniens (leader passes through foramen ovale); *d*, right atrium; *e*, left atrium; *f*, septum intermedium; *g*, right ventricle; *h*, ventricular septum; *i*, left ventricle.

spicuous lateral dilatations which assume a position above and behind the growing arterial chamber. These dilatations are the *auricular appendages* (Fig. 95), which for some time are the most conspicuous parts of the auricles. At this time the auricular and ventricular portions of the heart are imperfectly separated by a marked constriction, the *canalis auricularis.*

During the fourth week the conversion of the single into a double heart commences by the gradual growth of partitions from above downward within the auricle, and from below upward within the ventricle (Fig. 96, A); in addition, the primitive auriculo-ventricular canal becomes divided by the formation of an especial partition, the *septum intermedium.* The division of the heart-chambers progresses to complete separation, with the exception of an orifice in the lower part of the interauricular septum, which orifice remains until shortly after birth as the *foramen ovale.* The entrance of the venous blood into the auricular compartment is effected for some time through the single opening of the sinus venosus. Guarding this orifice are folds of the cardiac lining, one of which folds becomes prominent as the Eustachian valve, directing the blood-current through the foramen ovale. Later, the sinus venosus becomes included within the wall of the heart, and the three principal venous trunks emptying within the sinus—the two ducts of Cuvier and the primitive inferior vena cava—open directly into the auricular cavity by as many separate orifices; that of the left Cuvierian duct is represented by the mouth of the coronary sinus, which this trunk eventually becomes. The truncus arteriosus, the anterior primary arterial trunk, undergoes an independent division by the formation of the *aortic septum,* the partition beginning at some distance from the heart and approaching the latter from above downward. The vessels resulting from the division of the single truncus arteriosus afterward become the aorta and the pulmonary artery, and are limited respectively to the left and right halves of the ventricular compartment by the simultaneously developed interventricular septum.

The primitive heart, as well as the earliest blood-vessels, consists of a double wall, the outer layer representing the muscular and fibrous tissue, and the inner layer representing the endothelial lining. These two coats are for a time entirely distinct, the endothelial heart representing the general arrangement and division of the organ, and lying within the surrounding layer as a shrunken cast within a mould (see Fig. 106). The interval separating the endothelial from the muscular heart later becomes bridged by numerous connecting bands of tissue, the network of trabeculæ becoming closer and the intervening spaces smaller as development progresses. The consolidation of the cardiac walls, however, never is completely accomplished, indications of its imperfections being clearly seen in the arrangement of the conspicuous *columnæ carneæ* of the adult organ, in which the more or less isolated bands represent the thickened remains of the bridging trabeculæ connecting the endothelial heart with the denser surrounding capsule.

Arteries of the Fetus.—The early arterial circulation of the fetus differs in many details from that of the later stages. Conspicuous among these differences is the development of the series of aortic arches which extend from the anterior end of the truncus arteriosus around the primitive pharynx, within the visceral arches, and converge into the dorsal longitudinal vessels, the *primitive aortæ*, on each side. Five pairs of aortic arches (Figs. 93, 97) are

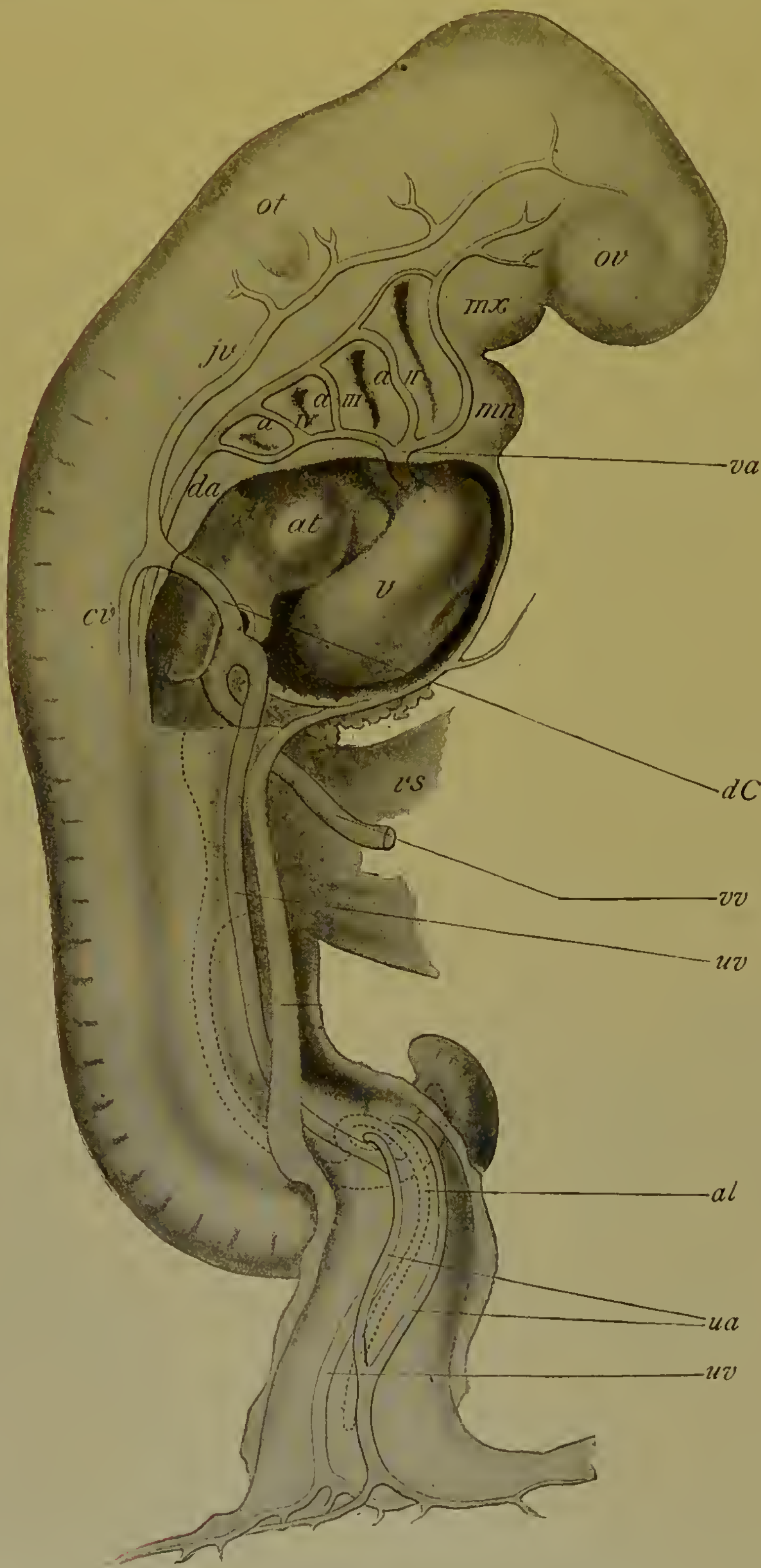


FIG. 97.—Human embryo of about three weeks, showing visceral arches and furrows and their relations to aortic arches (His): *mx*, *mn*, maxillary and mandibular processes of first visceral arch; *a I–a IV*, first to fourth aortic arches; *jv*, *cv*, primitive jugular and cardinal veins; *dC*, duct of Cuvier; *at*, *v*, atrium and ventricle of primitive heart; *vs*, vitelline sac; *va*, *da*, ventral and dorsal aortæ; *ov*, *ot*, optic and otic vesicles; *uv*, *ua*, umbilical veins and arteries; *vv*, vitelline vein; *al*, allantois.

formed, the first pair lying within the corresponding mandibular arch, the last within the tissues of the imperfectly defined fifth visceral bow. The first pair earliest appears and soonest disappears, all five at no time being found simultaneously fully developed, since by the twentieth day, when all are present, the anterior arches have already partly atrophied. These aortic arches in man and in mammals transiently represent the branchial circulation of gill-bearing types; their identity in the higher animals is lost in the metamorphosis which they undergo in the development of permanent trunks.

The fate of the several aortic arches and their relations to persistent structures is briefly as follows (Fig. 98):

(1) The first or mandibular aortic arch early in the fourth week loses its middle segment, the anterior limb taking part in the formation of the external

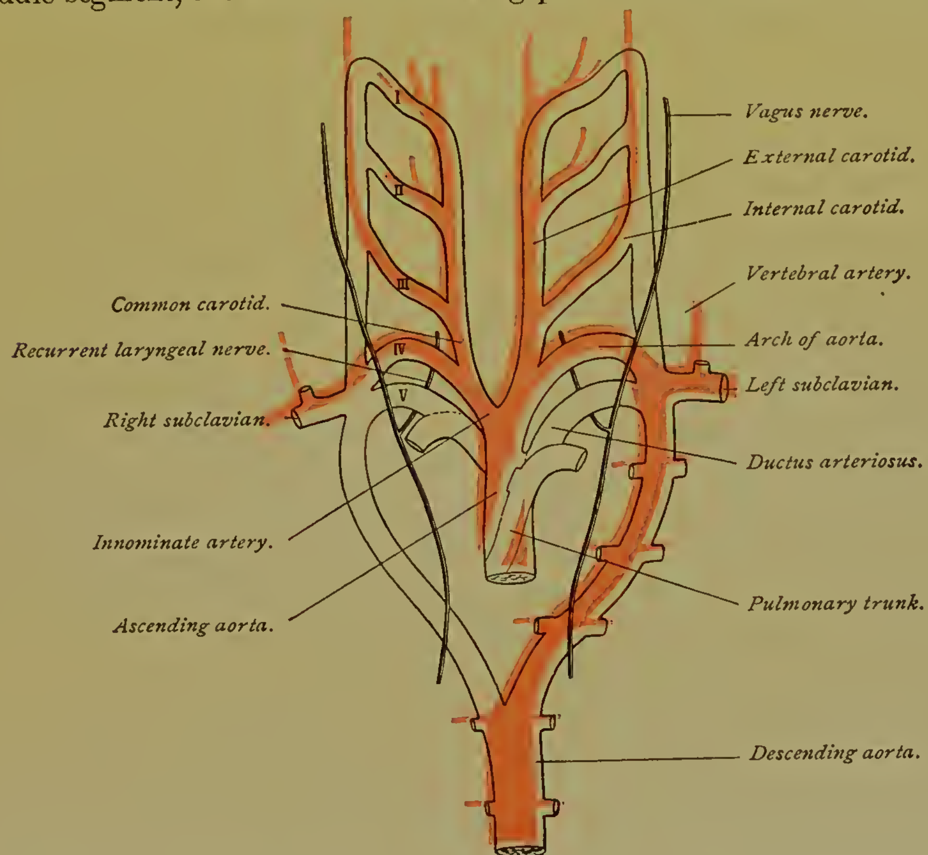


FIG. 98.—Diagram illustrating the fate of the aortic arches in mammals and man (modified from Rathke).

carotid artery and its branches; the posterior or aortic limb aids in forming the internal carotid artery.

(2) The second arch has a fate identical with that of the first, its straighter ventral and dorsal limbs taking part in producing the carotids.

(3) The third arch, which remains almost complete, gives rise to the connection between the external and internal carotid arteries, to the latter of which the arch particularly contributes.

(4) The fourth arch undergoes important changes resulting in its retention on the two sides, since from it are largely derived the innominate, together with the subclavian and vertebral arteries on the right side, and the important arch of the aorta on the left.

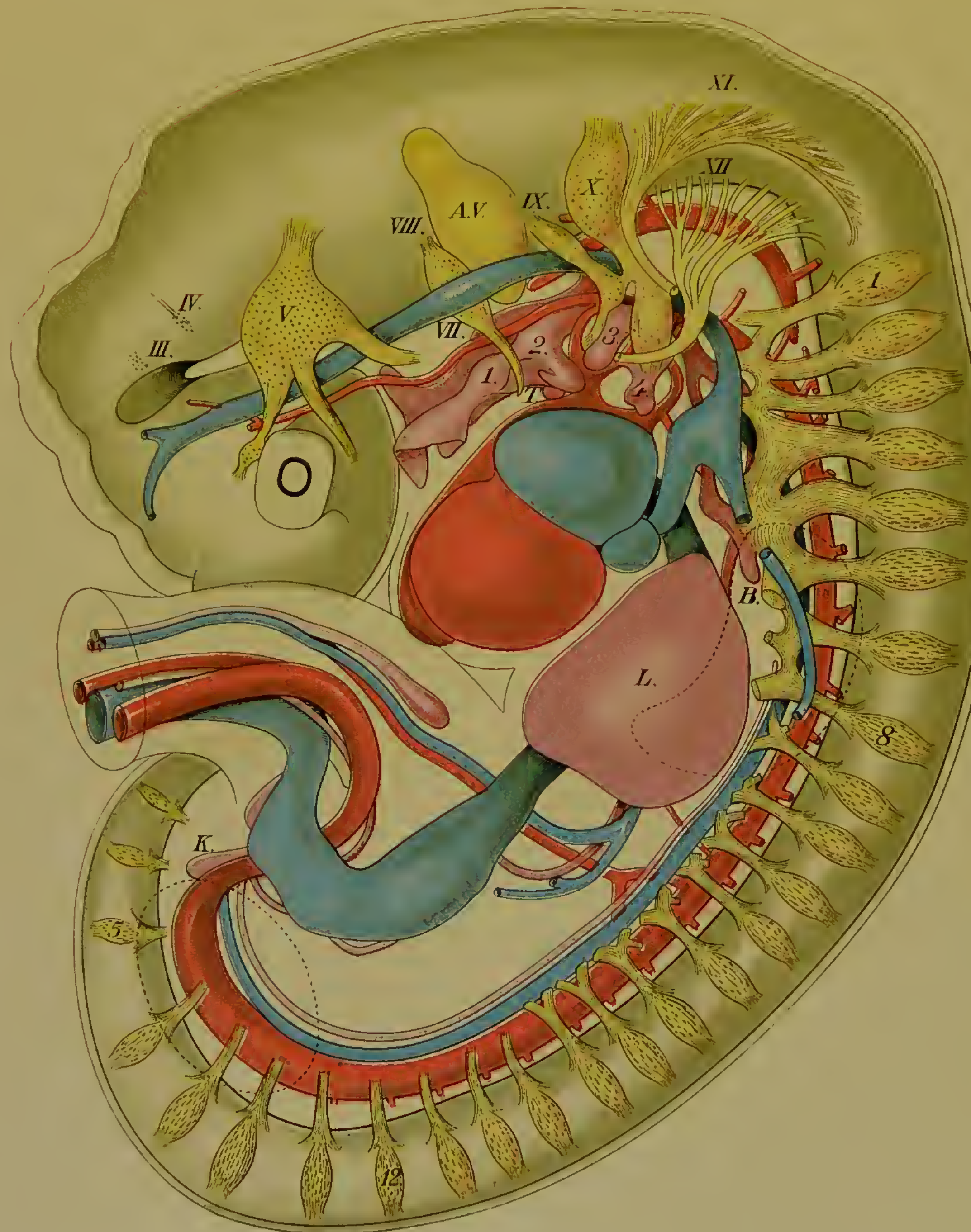
(5) The fifth arch is devoted to the production of the pulmonary arteries, a small portion of the right arch persisting as the right pulmonary artery, and a larger part of the left giving origin to the corresponding pulmonary artery and the ductus arteriosus.

During the fifth week, as before noted, the truncus arteriosus undergoes division into two tubes by the formation of the aortic septum; the resulting aortic tube retains connection with the fourth arch, becoming the ascending portion of the arch of the aorta, while the right tube becomes connected with the fifth arch and forms the pulmonary vessel.

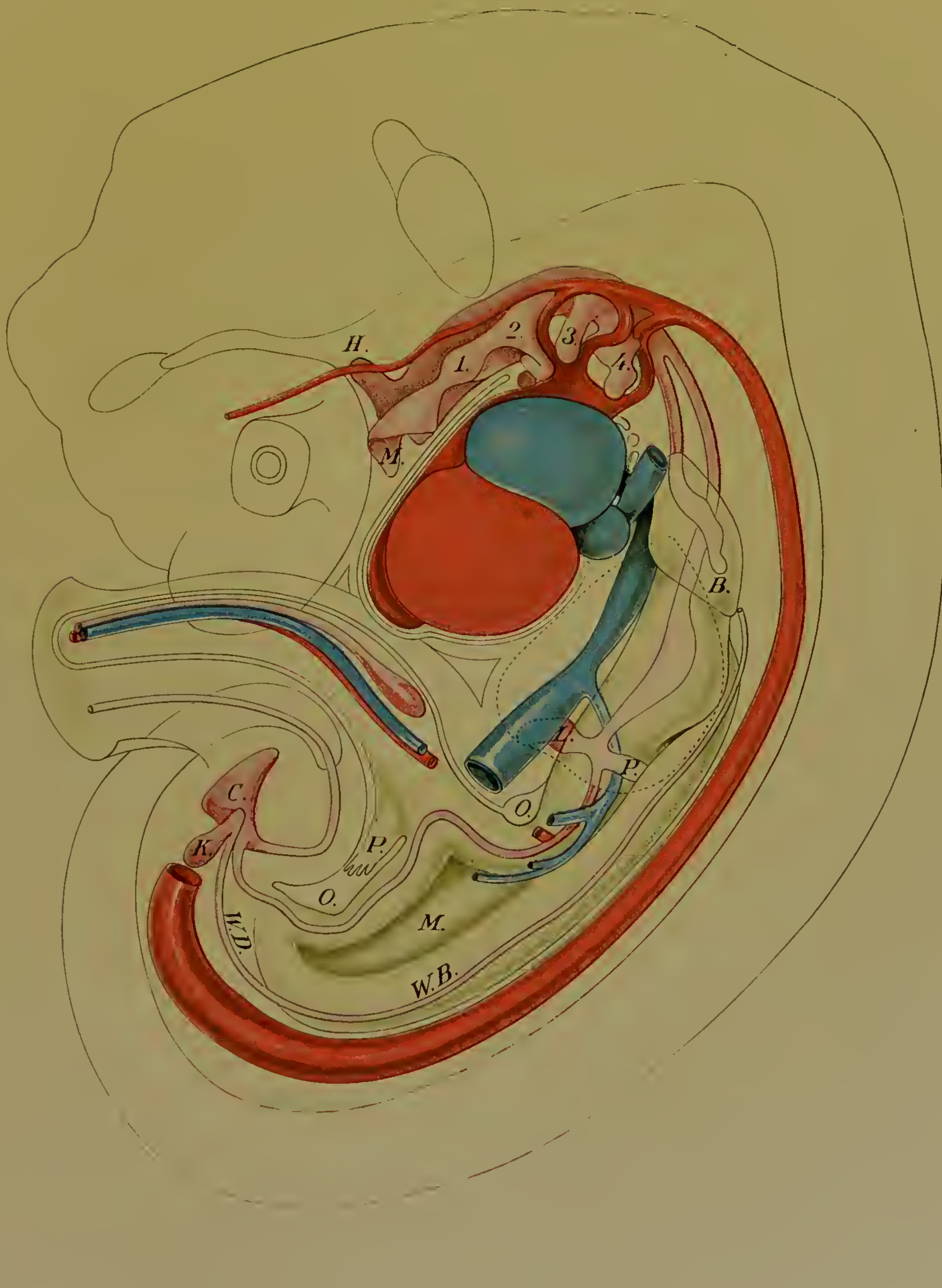
The two primitive aortæ for a time extend on each side of the notochord as longitudinal vessels which almost completely terminate in the large omphalo-mesenteric or vitelline arteries supplying the circulation of the yolk-sac, the early continuation of the aortic stems being slender, relatively insignificant branches which extend toward the caudal pole of the embryo. With the development of the earliest allantoic structures the posterior segments of the two primitive aortæ unite to form a single trunk, the dorsal aorta, the fusion beginning about the junction of the cervical and thoracic regions and proceeding caudally. At a slightly later period the aortic trunk divides, at the end of the lumbar region, into the allantoic arteries, which pass along the allantoic stalk and are distributed to the chorion, and later to the fetal placenta; they are then known as the *umbilical* arteries as far as the body-wall, being continued within the embryo as the *hypogastrics*. The primitive allantoic arteries eventually become the common and the internal iliac arteries, the external iliacs being formed as new branches when the limbs are developed. After birth, when the fetal placental circulation ceases, the distal parts of the hypogastrics beyond the bladder atrophy and remain as solid fibrous cords passing to the umbilicus; the proximal parts of these vessels retain their lumina and persist as the superior vesical arteries.

Veins of the Fetus.—Toward the close of the embryonal period, about the fourth week, the venous arrangement includes three distinct sets of vessels returning the blood to the heart (Pl. 16); these are—(1) The Cuvierian veins, returning the blood from the body of the embryo; (2) the vitelline veins, returning the blood from the circulation of the yolk-sac; (3) the allantoic, later the umbilical, veins, returning the blood from the chorion and the developing placental structures. The early systemic veins consist of an upper trunk, the *anterior cardinal* or primitive jugular veins, by which the blood from the head is carried to the heart, and the *posterior cardinals*, collecting the blood from the trunk and the important Wolffian bodies. These vessels, along with the vitelline and allantoic veins, pour their blood into a common receptacle, the *sinus venosus*, which opens directly into the primary auricular division of the heart. For a short time these veins are about equal in size and are evenly developed on the two sides; soon, however, the results of unequal growth become manifested in the disproportionate advance of some and the retrogression of others.

The vitelline veins in man, as may be anticipated from the relative insig-



Human embryo (reconstructed) of twenty-six days, viewed from the left side; magnified 25 diameters (after F. Mall): *III.* to *XII.*, the cranial nerves; 1, 8, 12, and 5, respectively the first cervical, the eighth cervical, the twelfth thoracic, and the fifth lumbar spinal nerve; *A. V.*, the auditory vesicle; 1, 2, 3, 4, respectively first, second, third, and fourth pharyngeal pouches; *T*, thyroid body; *B*, bronchus; *L*, liver; *K*, kidney. The dotted lines indicate the extremities.



Human embryo, same as preceding figure, but taken at a deeper plane (after F. Mall): *H*, diverticulum contributing the oral portion of the pituitary body; *M* (above), primitive mouth; 1, 2, 3, 4, pharyngeal pouches; *B*, bronchus; *P*, pancreas; *L*, liver; *W. B.*, Wolffian body; *W. D.*, Wolffian duct; *K*, kidney; *C*, cloaca; *O*, openings by which pleuro-peritoneal cavities communicate; *P*, papilliform projection into lower opening.

nificance of the mammalian yolk-sac, never reach the development seen in lower types. After passing along the vitelline stalk and entering at the umbilical opening, the veins run in front and then at the sides of that part of the primitive gut-tract corresponding with the duodenum, and become closely associated with the liver (Fig. 99). The vitelline veins become connected by three newly formed transverse trunks, thus establishing two vascular rings which encircle the gut. The early direct communication above these rings with the

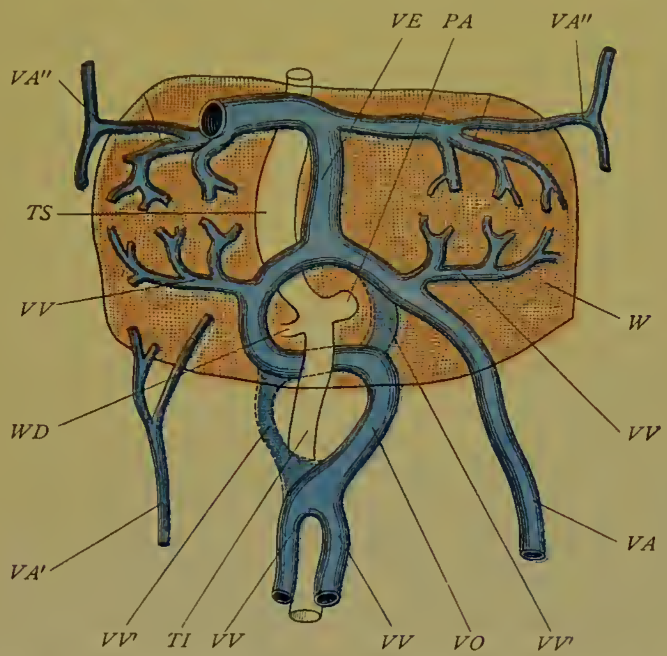


FIG. 99.—Development of the portal circulation of the human embryo of about three and a half weeks (Marshall, after His): *PA*, pancreas; *TI*, intestines; *TS*, stomach; *WD*, bile-duct; *VA*, left allantoic vein; *VA'*, right allantoic vein: *VA''*, anterior detached portions of the allantoic veins; *VE*, ductus venosus; *VO*, portal vein; *VV*, vitelline vein; *VV'*, portions of sinus annulares which disappear; *W*, liver.

sinus venosus becomes lost, and at the same time portions of the remaining parts of the vitelline veins become interrupted, while a new capillary system appears within the hepatic tissue, which has meanwhile surrounded the vessels, and provides communication between the veins themselves. Those portions of the vitelline vessels that pass from the upper venous ring to the capillary network are known as the *venæ advehentes:* they become the branches of the portal vein; those portions which pass from the capillary network to the sinus venosus, forming new relations, are the *venæ revehentes* and they become the *hepatic veins.* The vitelline veins at their lower communication become completely fused and receive veins from the intestinal tract, thus forming the main portal trunk.

The allantoic veins after the establishment of the placental circulation are known as the *umbilical veins,* of which for a time there are two. They fuse within the allantoic stalk, but remain as distinct vessels within the embryo, running within the lateral walls, for a much longer period. During the fourth week the connection of the allantoic veins with the sinus venosus is lost, and shortly afterward the right vein becomes much smaller than its fellow, and finally undergoes atrophy. The much larger left allantoic or umbilical vein joins the primitive portal vein just as this vessel enters the hepatic tissue.

The early condition of the placental circulation for a time is such that all blood returning by the allantoic vein must traverse the capillary network of the liver in order to gain access to the heart, since both vitelline and allantoic veins have lost their direct communication with the sinus venosus. After a time, however, the liver is no longer capable of giving passage to the rapidly increasing volume of the placental circulation, and then a direct communication is established between the portal vein and the right hepatic vein. This new passage is the *ductus venosus,* by which the greater part of the blood is carried to the heart without traversing the hepatic substance.

The systemic veins arise partly from the primary venous trunks and partly as new vessels. The ducts of Cuvier receive the primitive jugular veins above and the cardinal veins below. The primitive jugulars later become the permanent external jugulars, the internal jugulars being formed as new trunks. The Cuvierian ducts, which undergo change of direction and lengthening, take a position almost vertical, becoming the *superior venæ cavæ,* of which there are at first two. The development of the heart induces the disappearance of the greater part of the left superior cava, the proximal end, however, remaining as the insignificant coronary sinus which directly opens into the right auricle. With the atrophy of the left caval trunk a new transverse communication is necessitated to convey the blood from the left side to the remaining and enlarging superior cavæ. This need is supplied by the formation of the *transverse jugular,* which later becomes the greater part of the left innominate vein.

The fate of the once important posterior cardinal veins is linked with the history of the Wolffian bodies, whose venous outlet these veins largely are. With the atrophy of the Wolffian bodies the cardinal veins become less important, their final fate being partial disappearance and partial persistence as the azygos veins of adult anatomy.

The *inferior vena cava* presents a complicated development, for the details of which we are largely indebted to the recent investigations of Hochstetter. The inferior cava is developed partly as an independant trunk, and partly depends upon the appropriation of already existing veins. A new vessel is formed from the proximal end of the ductus venosus, from the point where that canal joins the hepatic veins, downward as far as the superior mesenteric artery, when it divides into two branches which join the primitive cardinals. This new vessel contributes the hepatic portion of the inferior vena cava. The further course of the latter vessel, as well as of the right common iliac vein, is provided for by the enlargement and extension of the lower part of the right primitive cardinal vein, that of the opposite disappearing. The external iliacs and the greater part of the left common iliac vein are new vessels.

7. **Development of the Digestive Tract.**—The formation of the digestive tube consists essentially in the folding off, closure, and isolation of that part

of the yolk-sac immediately in contact with the axial portions of the entoderm. This differentiation is effected by the ventral extension and approximation of the widely expanded splanchnopleure, which, bending together (Fig. 100), gradually closes to form the primitive gut—at first freely opening into the yolk-sac, finally completely isolated from the latter except through the communication maintained by the narrow umbilical duct.

By the fifteenth day the gut has become defined to such extent that three parts are distinguishable—the fore-gut, the mid-gut, and the hind-gut. The *fore-gut,* which includes the cephalic third of the tube, gives rise to the pharynx, the esophagus, and the stomach, the latter organ early appearing as a fusiform enlargement of the primitive canal. The anterior end of the fore-gut reaches as far forward as the marked cephalic flexure opposite the mid-brain, and at first is separated from the primitive oral invagination, or *sto-*

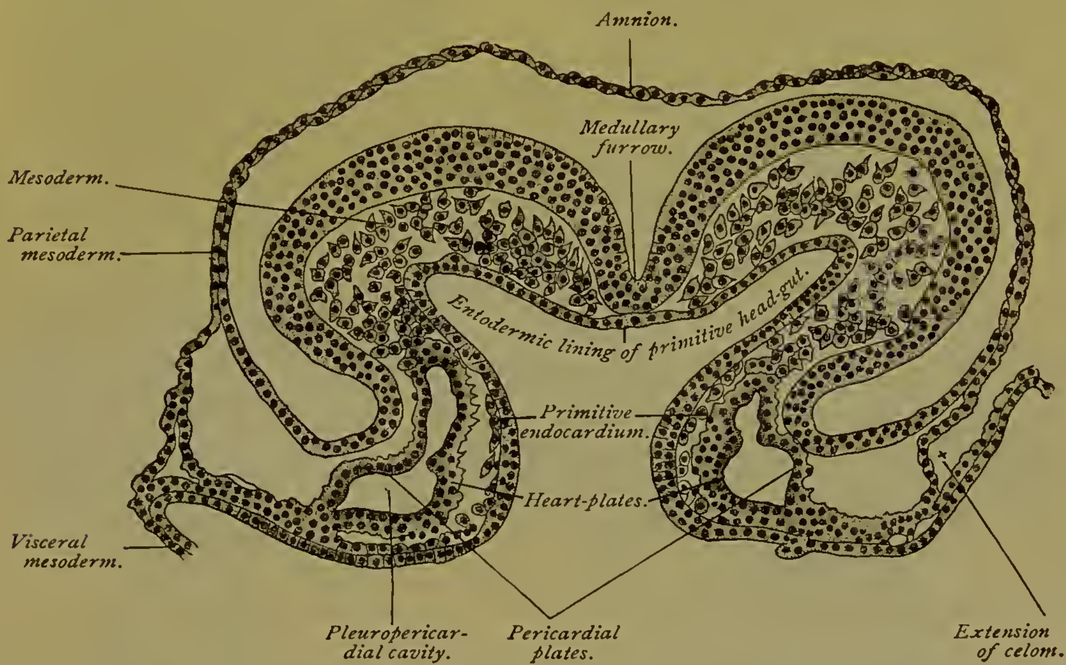


FIG. 100.—Transverse section of a sixteen and a half day sheep embryo (Bonnet).

matodæum (Fig. 101, A, B), by a septum consisting of the opposed ectodermic and entodermic layers. After the rupture of this partition, which happens during the fifteenth day, the primitive pharynx and oral cavity are directly continuous.

A series of four diverticula extend between the visceral arches, and constitute the *pharyngeal pouches* or *inner visceral furrows* (Fig. 106; Pl. 16). These evaginations of the pharyngeal lining are of interest, since the first pouch becomes converted into the Eustachian tube and the tympanic cavity, the third pouch into the early epithelial thymus body, and the fourth pouch into the lateral portions of the early thyroid body. From the ventral surface of the fore-gut, at the end of its pharyngeal division, there grows out the diverticulum, which gives rise to the respiratory tube and the epithelial parts of the pulmonary tissues.

The mid-gut, at first in free communication with the yolk-sac through the wide yolk-stalk, gradually becomes tubular and elongated, forming a narrow V-shaped loop whose straight and almost parallel limbs are attached behind to the dorsal wall of the body-cavity, above to the terminal part of the fore-gut at the stomach, and below to the hind-gut (Fig. 102). The apex of the loop receives the reduced yolk-stalk or umbilical duct, thereby becoming attached

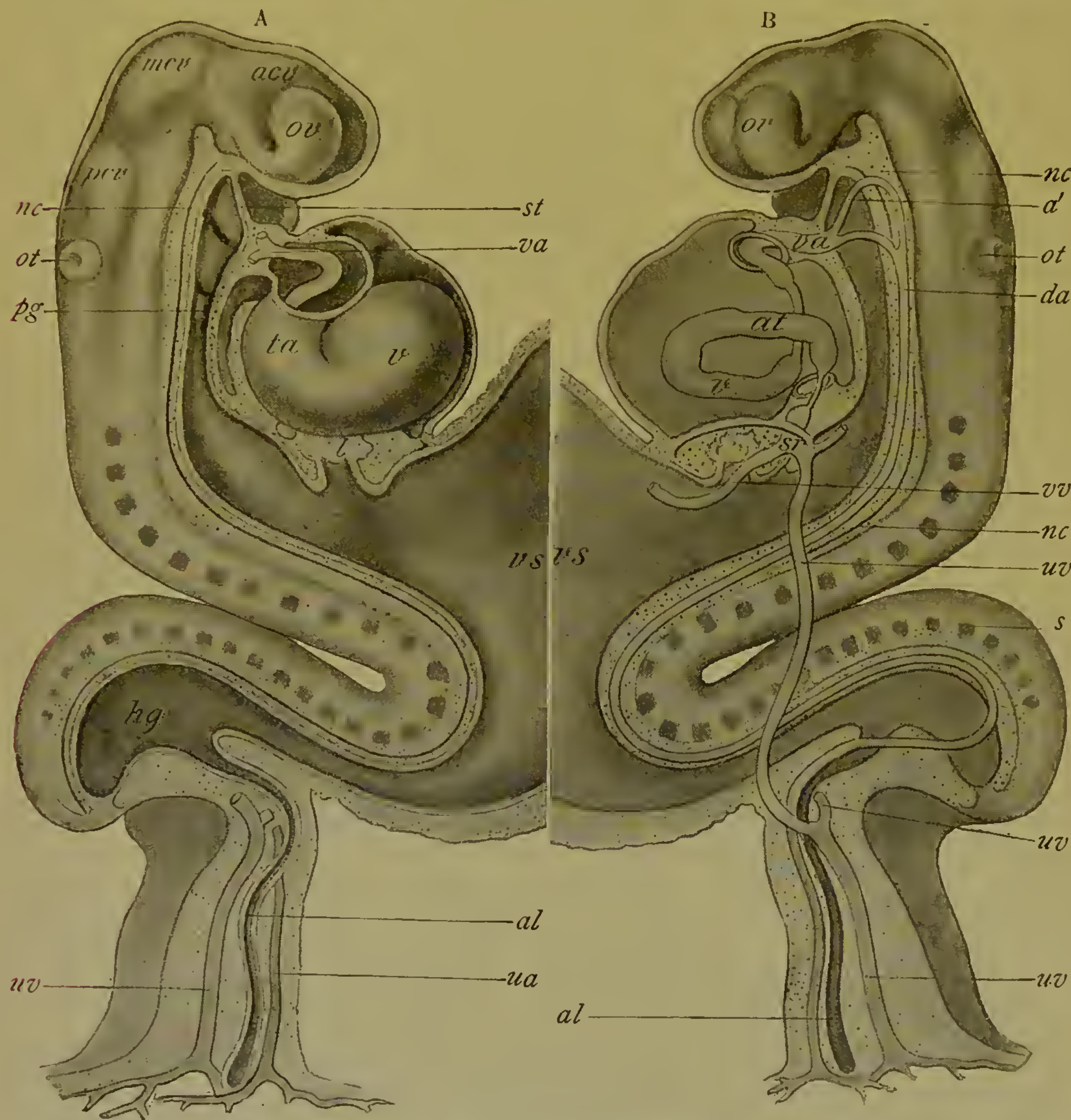


FIG. 101.—Reconstructions of human embryo of about fifteen days (His): *acv*, *mcv*, *pcv*, anterior, middle, and posterior primary brain-vesicles; *ov*, *ot*, optic and otic vesicles; *st*, septum between primitive oral cavity and head-gut; *pg*, primitive gut; *v*, *ta*, ventricular and aortic segments of heart; *a'*, aortic arch; *va*, *da*, ventral and dorsal aortæ; *l*, liver; *hg*, hind-gut; *nc*, notochord; *s*, somites; *sr*, sinus reuniens; *vv*, vitelline veins; *uv*, *ua*, umbilical veins and arteries; *al*, allantois.

to the ventral body-wall. The mid-gut gives rise to the entire small intestine and to the greater part of the large intestine. The liver and the pancreas are formed as diverticula and outgrowths from the lumen and the epithelial lining of the duodenal portion of the mid-gut.

The hind-gut soon loses its individuality and contributes the lower segment of the large intestine. In its primitive condition the hind-gut includes that portion of the gut-tract lying behind the open mid-gut and terminating blindly in the sharply flexed caudal pole of the embryo; the greatly

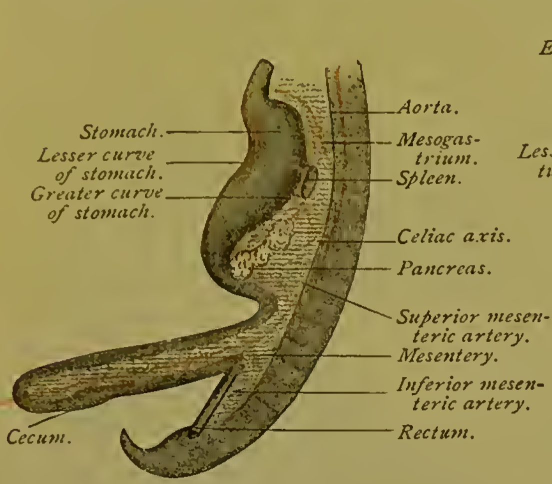


FIG. 102.—Intestinal canal of human embryo of six weeks (Toldt).

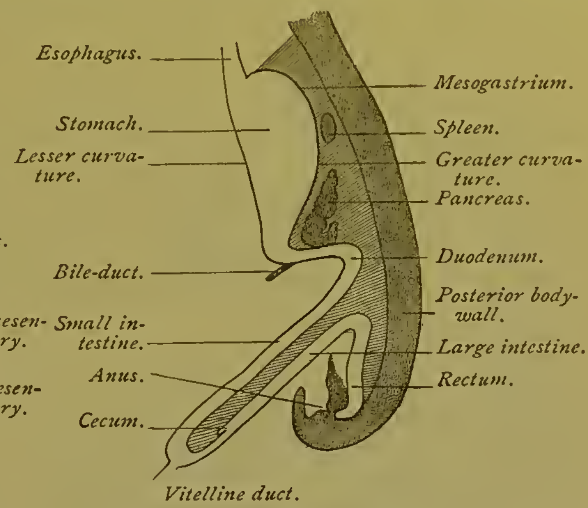


FIG. 103.—Digestive tract of human embryo of the sixth week (Toldt): arrangement of primitive visceral peritoneum.

dilated closed end of the tube constitutes the *cloaca,* the common receptacle for a time of the excretions of both the alimentary and the urinary tracts.

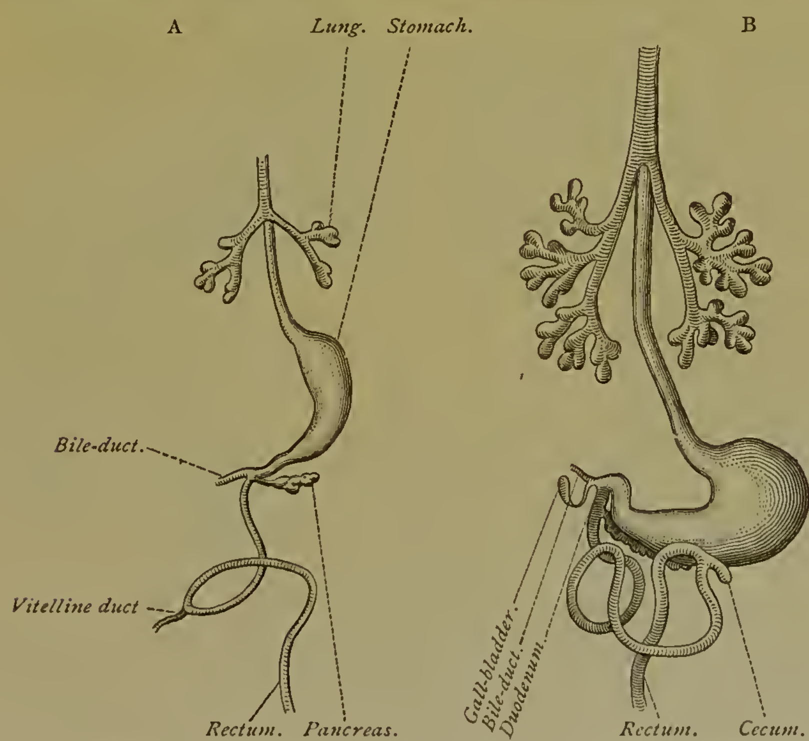


FIG. 104.—A, alimentary tract of human embryo of thirty-two days. B, alimentary tract of human embryo of thirty-five days (His).

The lumen of the allantoic sac, surrounded by the tissue of the allantoic stalk, extends from the ventral aspect of this space. At a later period communication with the exterior is established by the formation of the anal orifice. The external position of this opening is indicated by the *anal invagination* of the ectoderm or *proctodeum.*

During the early part of the fourth week the intestinal tube, composed of its several characteristic segments, lies in the sagittal plane attached to the dorsal wall of the body-cavity by the straight primitive mesentery (Fig. 103). A few days later a period of rapid growth is inaugurated, the intestinal tube increasing in length with far greater rapidity than the abdominal cavity expands. In consequence of this inequality in growth the small intestines become twisted and coiled, while the large gut takes up a position in front or ventrally, and above the turns of the smaller tube.

During the fifth week (Fig. 104) the esophagus elongates and the stomach acquires its characteristic form as well as an obliquely transverse position, its

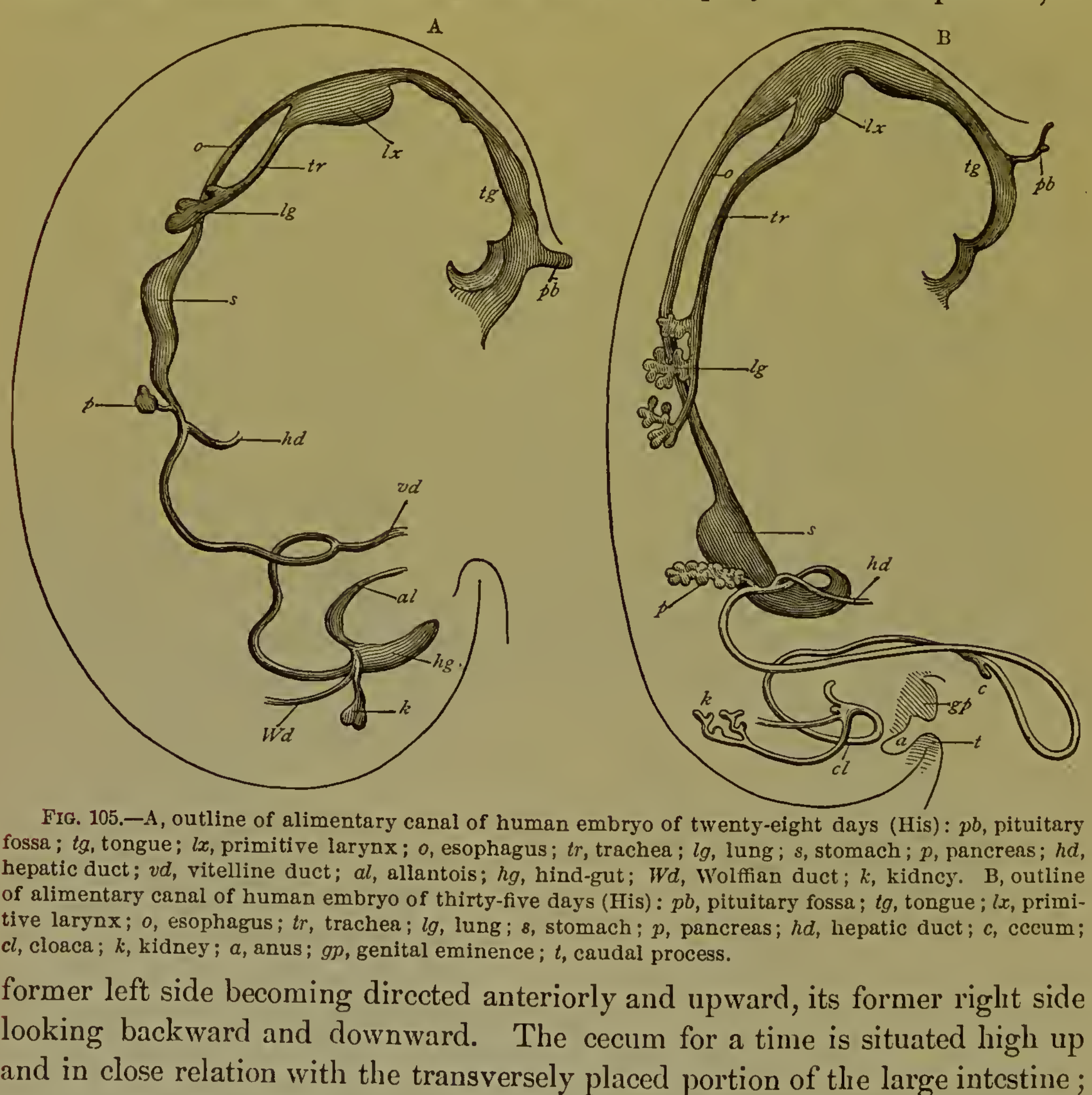


Fig. 105.—A, outline of alimentary canal of human embryo of twenty-eight days (His): *pb*, pituitary fossa; *tg*, tongue; *lx*, primitive larynx; *o*, esophagus; *tr*, trachea; *lg*, lung; *s*, stomach; *p*, pancreas; *hd*, hepatic duct; *vd*, vitelline duct; *al*, allantois; *hg*, hind-gut; *Wd*, Wolffian duct; *k*, kidney. B, outline of alimentary canal of human embryo of thirty-five days (His): *pb*, pituitary fossa; *tg*, tongue; *lx*, primitive larynx; *o*, esophagus; *tr*, trachea; *lg*, lung; *s*, stomach; *p*, pancreas; *hd*, hepatic duct; *c*, cecum; *cl*, cloaca; *k*, kidney; *a*, anus; *gp*, genital eminence; *t*, caudal process.

former left side becoming directed anteriorly and upward, its former right side looking backward and downward. The cecum for a time is situated high up and in close relation with the transversely placed portion of the large intestine; later the blind end of this part of the gut descends, owing to the development of an intermediate portion which assumes the position and characteristics of the ascending colon. The cecum for a time is of uniform size; its further growth, however, is marked by the failure of the apical portion to keep pace with the increase in size of the remaining parts of the gut; in consequence, that portion which morphologically represents the end of the cecum remains as a narrow tubular attachment connected with the head of the large gut, this appendage constituting the *appendix vermiformis*—the oldest part of the cecum.

The connection of the yolk-stalk or vitelline duct (Fig. 105) with the intestinal canal rapidly becomes less conspicuous, and by the end of the fifth week the yolk-stalk has but slight connection with the gut. The position of the

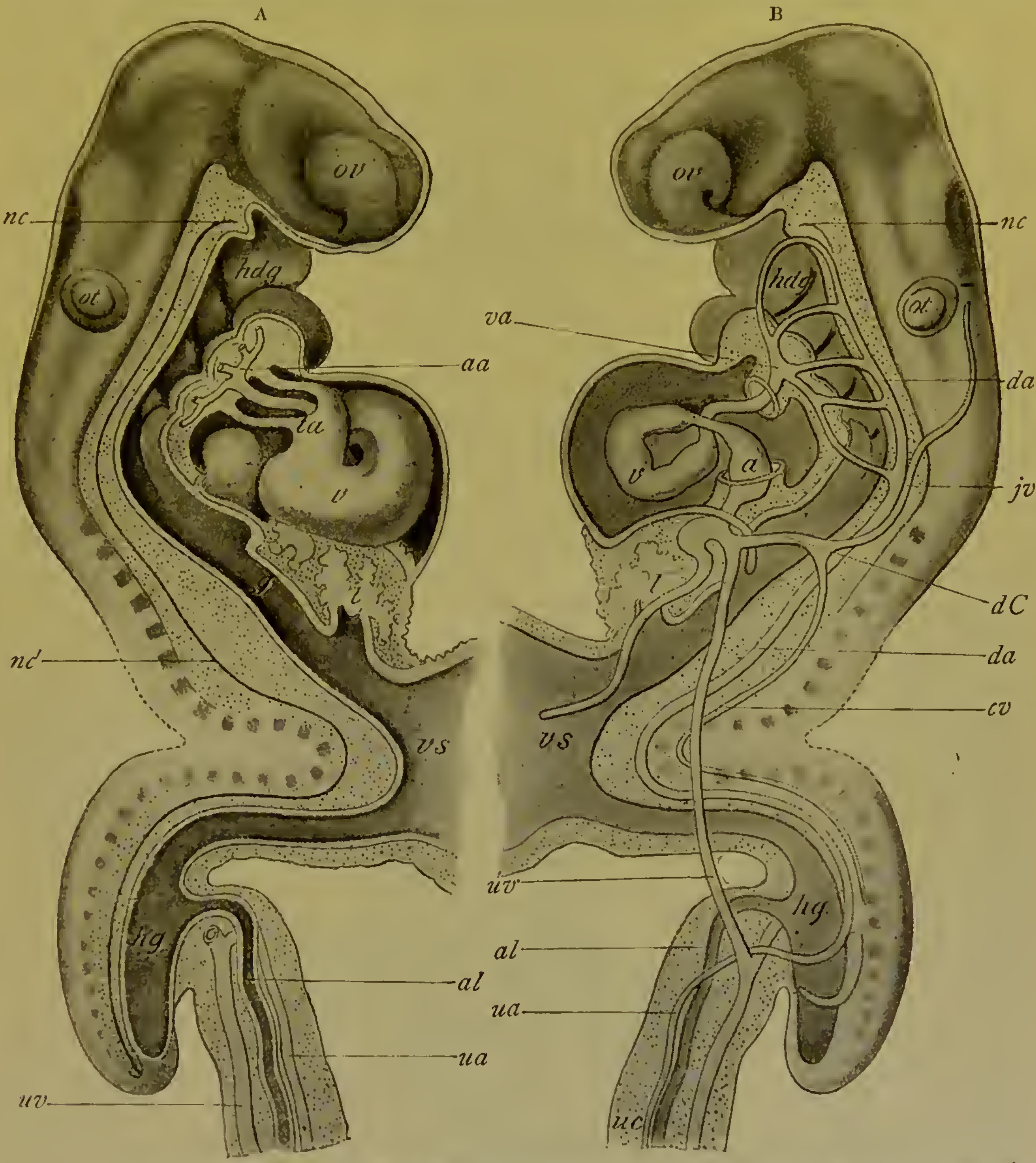


FIG. 106.—Reconstructions of human embryo of about seventeen days (His): *ov*, optic and *ot*, otic vesicles; *nc*, *nc'*, notochord; *hdg*, head-gut; *g*, mid-gut; *hg*, hind-gut; *vs*, vitelline sac; *l*, liver; *v*, *ta*, primitive ventricle and truncus arteriosus; *va*, *da*, ventral and dorsal aortæ; *aa*, aortic arches; *jv*, primitive jugular vein; *cv*, cardinal vein; *dC*, duct of Cuvier; *uv*, *ua*, umbilical vein and artery; *al*, allantois; *uc*, umbilical cord.

juncture of the vitelline duct with the intestinal tract varies greatly, but usually corresponds with a point within the small intestine from 40 to 60 centimeters (16 to 24 inches) from the ilio-cecal valve. When the usually atrophic cord is replaced by a tubular recess, the persistent portion of the duct constitutes Meckel's diverticulum, a structure of interest. The vitelline duct may remain pervious throughout its intra-embryonal extent, resulting sometimes in congenital umbilical fistula. The ventrally situated intestinal loops for a time extend through the umbilical opening into the allantoic stalk, in which, up to the twelfth week, they are normally present; after the third month, however, the coils are permanently withdrawn into the abdominal cavity.

The *liver* first appears about the fifteenth day as a diverticulum (Fig. 106) from the ventral wall of the fore-gut, surrounded at its end by a thick layer of cells. The organ is rapidly formed, the single diverticulum almost immediately dividing into two, which in turn send off secondary and tertiary sprout-like extensions of solid cell-masses. These cylindrical masses anastomose and form networks of cells throughout the mesodermic tissue assigned to the production of the liver. The spaces within the meshworks are occupied by the richly vascular mesodermic tissue which supplies the connective tissue and the contained blood-vessels and bile-ducts.

The *pancreas* (Fig. 105) and the *salivary glands* are developed as solid outgrowths from the epithelium of the digestive tract. The cylindrical cell-masses at first are slender, solid, and rather club-shaped at their free ends. They later acquire a lumen and expand into the characteristic compartments of a racemose gland.

8. **Respiratory Tract.**—The respiratory tract is closely related in its development with the digestive canal, since it is formed by a direct evagination from the ventral wall of the lower portion of the primitive pharynx. The primitive trachea grows downward for some distance parallel with the esophagus, and then divides into branches which correspond to the primary and secondary bronchi (Figs. 104, 105); subsequently each of these undergoes repeated dichotomous division, the resulting twigs in turn giving rise to smaller branches until the ultimate compartments of the pulmonary tissue are developed. The smaller primary bronchioles are solid cylinders at first, their lumina appearing later. The entodermic portion of the respiratory tract, directly derived from that of the primary digestive tube, forms the epithelial parts of the organs, the connective tissues and vascular constituents of the same being products of the mesodermic tracts into which extend the epithelial masses.

9. **Development of the Genito-urinary Organs.**—The early stages of the human embryo, as well as of other mammals, mark the appearance of the paired Wolffian bodies and the Wolffian ducts, which for a time represent a functionating excretory apparatus (Pl. 16), the ancestor of the permanent kidneys.

The *Wolffian duct* appears about the fifteenth day as a longitudinal cell-mass extending throughout the posterior half of the embryo. The duct is formed by the evagination and isolation of portions of the mesothelial lining of the body-cavity, the resulting cylindrical cell-mass forming a cord that extends at first to the surface ectoderm, with which it has temporarily close relations (Fig. 107). These appearances have given rise to the views advanced by several investigators, according to which the Wolffian duct is ectodermic in origin. Careful examinations of suitable preparations show that the relations of the developing Wolffian duct to the ectoderm are only secondary, and that the initial steps in the formation of the duct occur, as stated, as evaginations of the mesothelium; the Wolffian duct therefore is a product of the mesoderm. After a time the blindly terminating distal ends of the ducts sink centrally and acquire a communication with the cloacal expansion of the hind-gut. At first the ducts are solid cylinders; subsequently they possess a lumen.

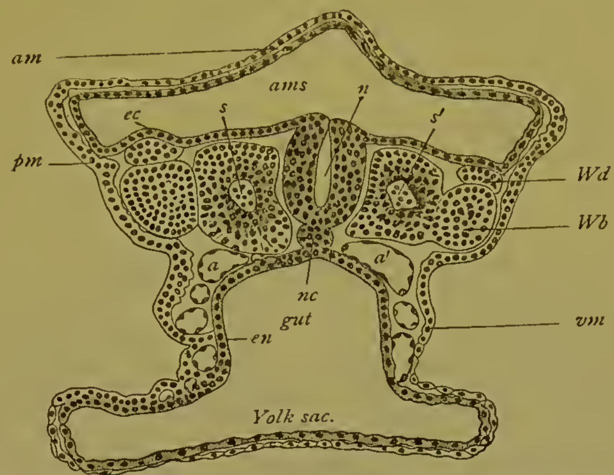


FIG. 107.—Transverse section of sixteen day sheep embryo (Bonnet): *ec*, ectoderm; *en*, entoderm; *pm*, parietal mesoderm; *vm*, visceral mesoderm; *am*, amnion; *ams*, amniotic sac; *s*, *s'*, somites; *a*, *a'*, aortæ; *nc*, notochord; *n*, neural canal; *Wd*, Wolffian duct; *Wb*, Wolffian body.

Some days later, usually about the eighteenth day, the *Wolffian bodies* appear as a series of short cylinders (Fig. 108) which form as buds from the mesothelium of the body-cavity entirely independently of the development of the Wolffian duct. These rods of cells at first are solid; during the fourth week they acquire lumina and become the Wolffian tubules, and later grow toward and join with the Wolffian ducts. The closed ends of the tubules

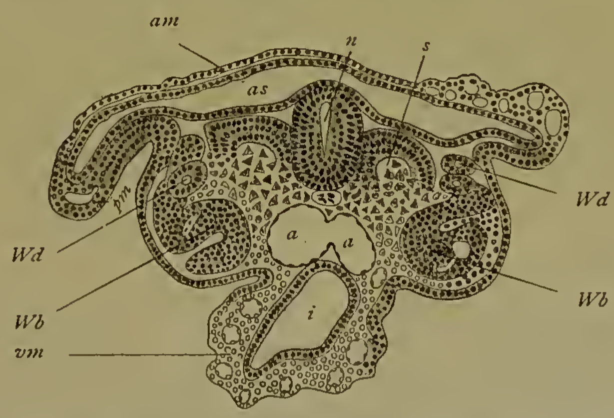


FIG. 108.—Transverse section of seventeen day sheep embryo (Bonnet): *am*, amnion; *as*, amniotic sac; *n*, neural canal; *s*, somite differentiated into muscle-plate; *Wd*, Wolffian duct; *Wb*, Wolffian body; *pm*, parietal mesoderm; *vm*, visceral mesoderm; *a*, *a*, fusing primitive aortæ; *i*, intestine.

become expanded and then invaginated by the apposition of blood-vessels sent into the bodies from the aorta. The tufted blood-vessels and the invaginated tubule constitute the Malpighian bodies of the Wolffian bodies, the predecessors of the similar structures of the permanent kidney. All parts of the Wolffian bodies, therefore, are derived from the mesodermic tissues. Secondary tubules are formed as outgrowths from the primary ones whose origin has been sketched above.

The Wolffian bodies increase rapidly during the second month, gaining in size by the growth of the primary tubules and by the formation of new ones. These bodies act for a time as functionating excretory organs, the period of their greatest development being about the eighth week. After this time they undergo retrogressive change, so that by the fifth month the Malpighian bodies have largely disappeared and the entire organs become atrophic.

In view of important differences in growth, functional activity, and morphological significance of various parts of the Wolffian body, there are recog-

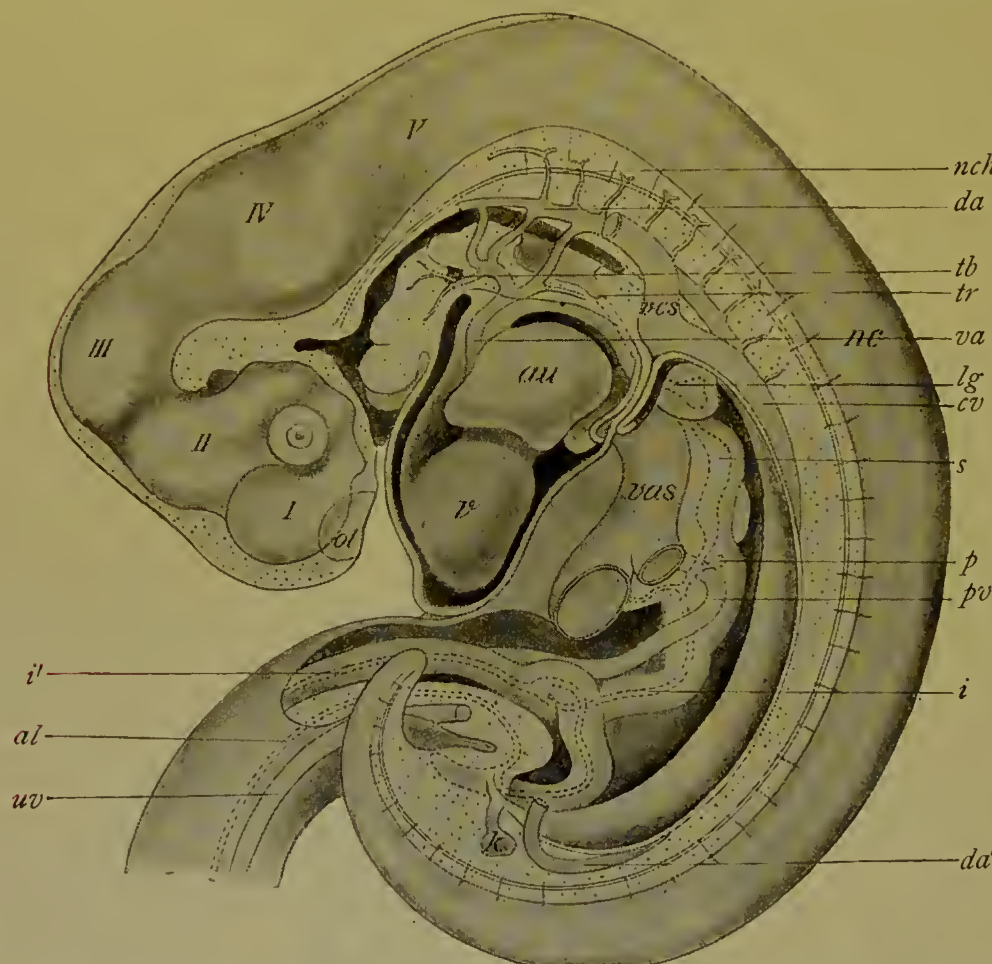


FIG. 109.—Reconstructed human embryo of about twenty-eight days (His): *I–IV*, brain-vesicles· *nc*, neural canal; *nch*, notochord; *ol*, olfactory pit; *v*, *au*, cardiac ventricle and auricle; *va*, *da*, ventral and dorsal aortæ; *da'*, termination of dorsal aorta; *tb*, median part of thyroid body; *tr*, larynx; *lg*, lung; *s*, stomach; *p*, pancreas; *i*, intestine; *i'*, intesto-vitelline duct; *al*, allantoic duct; *k*, kidney; *vcs*, left superior vena cava; *cv*, cardinal vein; *pv*, portal vein; *vas*, vena ascendens, collecting blood from umbilical and portal veins; *uv*, umbilical vein.

nized an *anterior segment*, corresponding with the head-kidney of lower types, always backward in its development in mammals; a *middle segment*, which from its relation to the generative organs in their formation may be regarded as the sexual portion of the organ; and a *posterior segment*, likewise rudimentary in development and in the nature of the organs to which it contributes. The middle segment is of most importance both functionally and morphologically: this portion is sometimes designated the *mesonephros*.

The Müllerian Duct.—Coincidently with the formation of the Wolffian duct, during the fourth week, an extended ridge of thickened mesothelium appears along the outer side of each Wolffian body, from which, however, this ridge is entirely independent. These ridges represent the early condition of the Müllerian ducts, the lumina appearing within the cell-cords about the fifth week. The Müllerian duet ends blindly below, and later possesses an expanded, trumpet-shaped anterior end. Its important morphological relations are considered in subsequent paragraphs.

The permanent excretory organ, the kidney, and its duct, the ureter, are derived primarily as outgrowths from the lower end of the Wolffian duct (Pl. 16, B; Figs. 105, 109). About the fourth week a diverticulum grows from the hinder end of the duct forward and dorsally into a mesodermie area close to and behind the lower end of the Wolffian body. The tube thus formed is the primitive ureter, which extends within the mesodermic tissue, where, after expanding into the immature pelvis, it breaks up into a number of tubes eorresponding with the caliees, from which pass epithelial cylinders representing the epithelial portions of the uriniferous tubules. Later the vascular mesoderm contributes the primitive glomeruli, which meet the expanded ends of the tubules and take part in the further development of the Malpighian bodies of the kidney. By the end of the second month the definite character of the renal structure has become established. As the permanent organ increases in size and functional importance the Wolffian body rapidly atrophies, so that by the end of the fourth month its activity as an exeretory organ has disappeared, the parts still remaining bearing relations to the sexual apparatus alone.

The *bladder* is the persistent and expanded proximal portion of the allantoic duct which retains its lumen, while that of the distal segment of the same duct loses its lumen about the fifth week, becoming converted into a solid fibrous cord, the *urachus*, which stretches from the summit of the urinary bladder to the umbilicus. The bladder therefore differs from the kidney and the ureter in possessing a lining derived from the entoderm, and in not being entirely of mesodermic origin.

The formation of the internal generative organs consists of two distinct developmental processes, the development of the sexual glands and that of their excretory passages. At the end of the first month the mesothelial covering of the Wolffian bodies, along their inner borders, shows an extended area of thickening and proliferation, the resulting elevated bands, the *genital ridges*, being the earliest traces of the sexual glands. For a short time these glands are of an indifferent type (Fig. 110), the differential charaeteristics of the two sexes not being manifested, seemingly, for some days; the primitive male gland then exhibits a disposition to form networks of tortuous anastomosing cell-cords (Fig. 111), the forerunners of the seminiferous tubules; the female gland, on the contrary, possesses a larger number of the *primitive sexual cells*, and evinces a tendency of its elements to arrange themselves into groups in which the larger primitive ova become central figures. Microscopical examination of the sexual primitive glands even at the end of the fifth week is capable of distinguishing the future sex of the being. It is highly probable, as emphasized by Nagel, that inherent sexual differences exist in the glands from their earliest appearance, and that the recognition of the indifferent stage depends largely upon our imperfect appreciation of these distinctions.

The development of the second part of the sexual apparatus, the system of excretory passages, depends upon the appropriation and modification of already existing tubes, the tubules of the Wolffian body, the Wolffian duct, and the

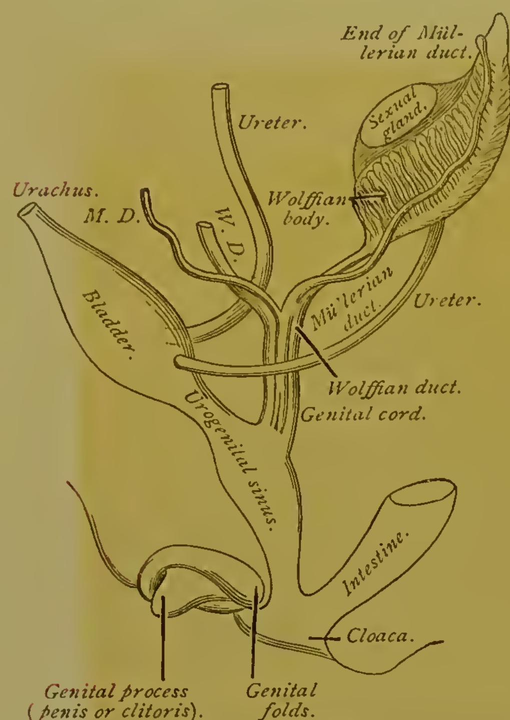


FIG. 110.—Diagram representing the indifferent stage in the development of the generative organs (modified from Allen Thompson).

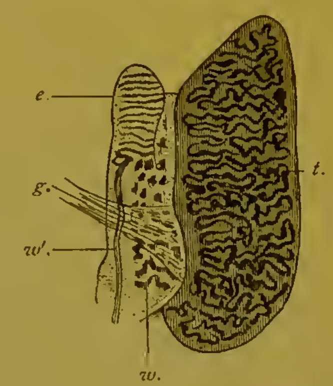


FIG. 111.—Internal generative organs of a male fetus of about fourteen weeks (Waldeyer): *t*, testicle; *e*, epididymis; *w'*, Wolffian duct; *w*, lower part of Wolffian body; *g*, gubernaculum testis.

Müllerian duct. The fate of these structures varies with sex. In the female (Fig. 112) the Müllerian ducts are most important; they develop into the oviducts, and, after becoming fused, into the uterus and the vagina, while the Wolffian bodies and duct give rise at best to atrophic structures. The Wolff-

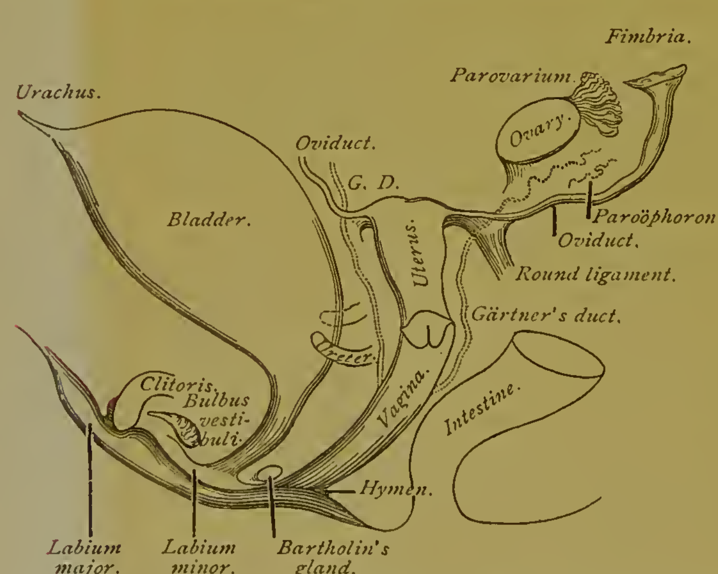


FIG. 112.—Diagram illustrating changes taking place in development of female generative organs (modified from Allen Thompson).

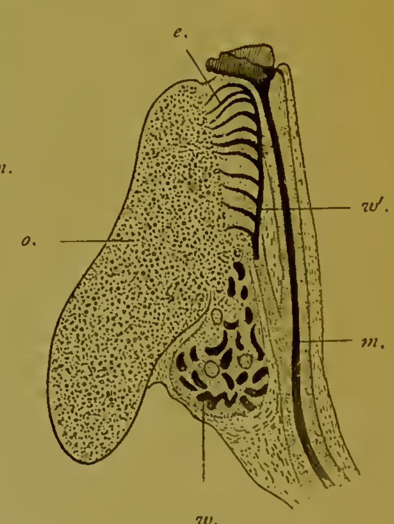


FIG. 113.—Internal organs of a female fetus of about fourteen weeks (Waldeyer): *o*, ovary; *e*, epoöphoron or parovarium; *w'*, Wolffian duct; *m*, Müllerian duct; *w*, lower part of the Wolffian body.

ian body in the female contributes the *transverse tubules* of the parovarium or epoöphoron, the upper part of the Wolffian duct remaining as the *head-tube* of the same atrophic organ (Fig. 113). When the Wolffian duct persists it constitutes Gärtner's duct. In the male subject (Fig. 114), on the contrary, the

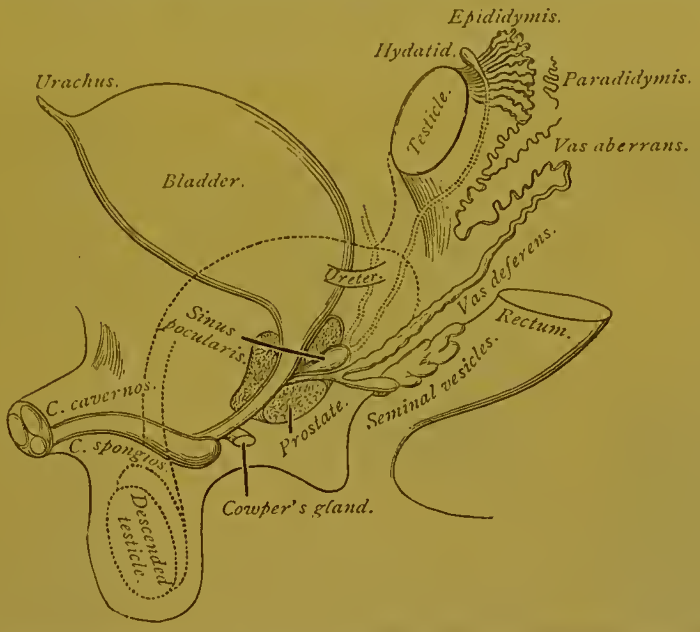


FIG. 114.—Diagram illustrating changes taking place in development of male generative organs (modified from Allen Thompson).

Wolffian tubules and the Wolffian duct contribute the important system of excretory tubes represented by the vasa efferentia, the coni vasculosi, the tube of the epididymis, and the vas deferens, while the Müllerian duct is atrophic, its extreme ends alone remaining as the sessile hydatid of Morgagni, closely connected with the globus major of the epididymis, and as the sinus pocularis or *uterus masculinus*, opening into the prostatic portion of the urethra.

The atrophic tubules of the lower segment of the Wolffian body in both sexes contribute rudimentary organs, the *paradidymis* and the *paroöphoron* respectively, which consist of a few tortuous tubules situated in the epididymis and in the broad ligament near the parovarium. The stalked hydatids of Morgagni, which are common to both sexes, probably represent portions of the atrophic head-kidney and its duct.

The External Genital Organs.—Until the ninth or tenth week the external genitalia afford no positive information as to sex, since these parts until this time represent a practically indifferent type (Fig. 115).

Up to the sixth week the external openings of the gut and of the urinary tract are received within a common cloacal recess whose recto-urogenital orifice is surmounted by a small conical elevation, the *genital tubercle;* the lower and posterior surface of this eminence is divided by a furrow, the *genital groove,* bounded by thickened lips, the *genital folds;* outside the latter a less conspicuous elliptical fold constitutes the *genital ridges.* The end of the genital tubercle enlarges and forms a knob-like expansion, the primitive glans either of the future penis or of the clitoris. Toward the end of the second month the imperfectly formed septum between the rectum and the urinogenital passage reaches perfection, whereby the complete separation between the alimentary and genito-urinary canals is effected.

In the male (Fig. 115, C, E, G) the genital tubercle elongates to form the penis, while the lips of the genital furrow on its under surface unite to form the

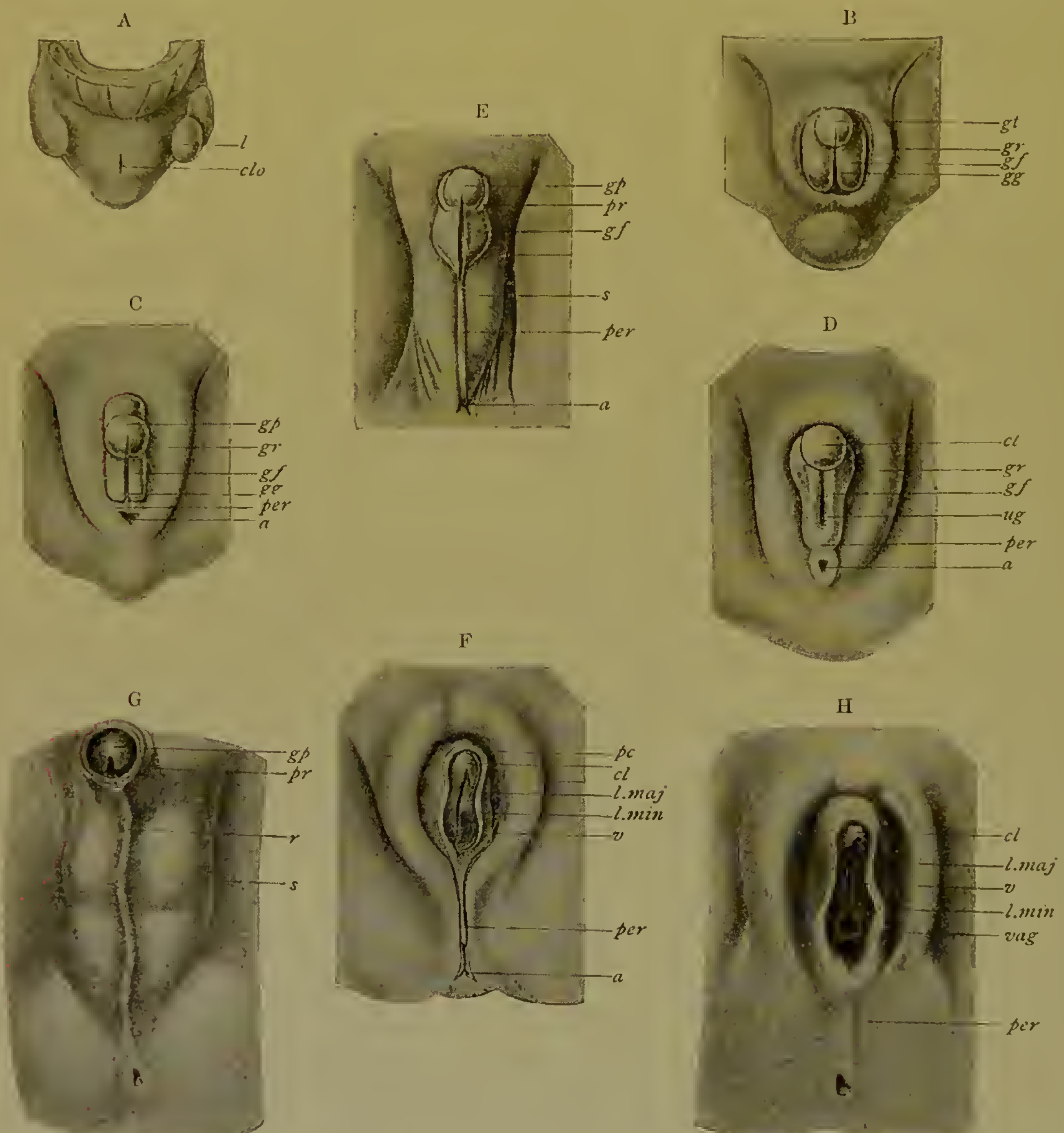


FIG. 115.—Development of external genital organs of human fetus (Ecker-Ziegler models): A, B, indifferent type, fifth to eighth week: *clo*, cloaca; *l*, lower limb; *gt*, genital tubercle; *gr*, genital ridge; *gf*, genital fold; *gg*, genital groove. C, E, G, organs of male type: *gp*, glans penis; *gr*, genital ridge; *gf*, genital fold; *gg*, genital groove; *per*, perineum; *a*, anus; *pr*, prepuce; *s*, scrotum; *r*, raphe. D, F, H, organs of female type: *cl*, clitoris; *gr*, genital ridges; *gf*, genital folds; *ug*, urinogenital fissure; *per*, perineum; *a*, anus; *pc*, prepuce of clitoris; *l.maj*, labia majora; *l.min*, labia minora; *v*, vestibule; *vag*, vagina.

penile portion of the urethra; coincidently, the closure of the edges of the urinogenital passage takes place, the tube thus formed becoming continuous with the anterior part of the urethra just formed. The primitive genital ridges or outer genital folds grow together and eventually form the scrotum, into which the testicles descend shortly before birth.

In the female (Fig. 115, D, F, H) the genital tubercle remains relatively small and becomes the clitoris; the genital furrow remains open, the bounding genital folds forming the labia minora or the nymphæ, and the external folds forming the labia majora. At first the clitoris is disproportionately large, but later it becomes overshadowed by the rapidly growing labia. Usually, by the end of

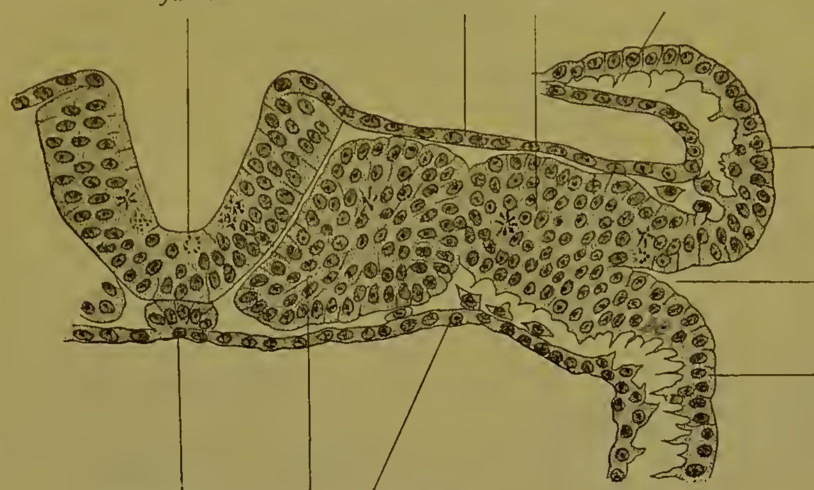


FIG. 116.—Transverse section of a sixteen and a half day sheep embryo possessing six somites (Bonnet).

the third month the external sexual characteristics of the fetus are established beyond doubt. Imperfect development, especially faulty union, of certain parts of the primitive genitalia produce the conditions which give rise to apparent hermaphroditism: true hermaphrodites, while not impossibilities, are

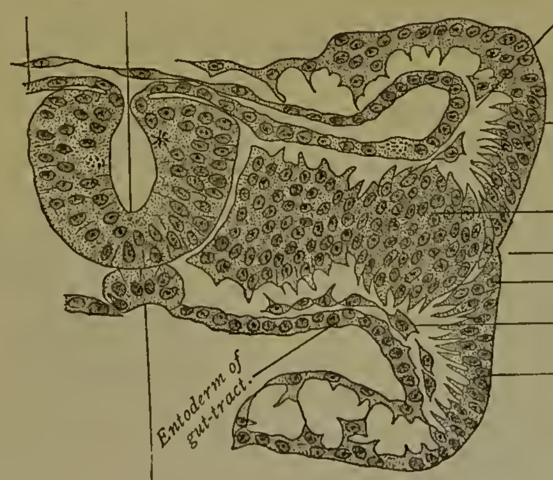


FIG. 117.—Transverse section of a fifteen and a half day sheep embryo possessing seven somites (Bonnet).

among the rarest malformations, since in them the formation of true sexual organs of both sexes must take place in the same individual.

10. **Development of the Nervous System.**—The initial stage in the production of the great cerebro-spinal nervous axis is the formation of the medullary folds and groove (Figs. 116, 117), one of the earliest of the fundamental

processes in the development of the embryo. At the thirteenth day the neural groove is widely open throughout its extent; two days later, by the beginning of the third week, the groove has become converted into a closed canal by the approximation of the thickened neural plates along the dorsal mid-line. The cephalic extremity of the neural canal,

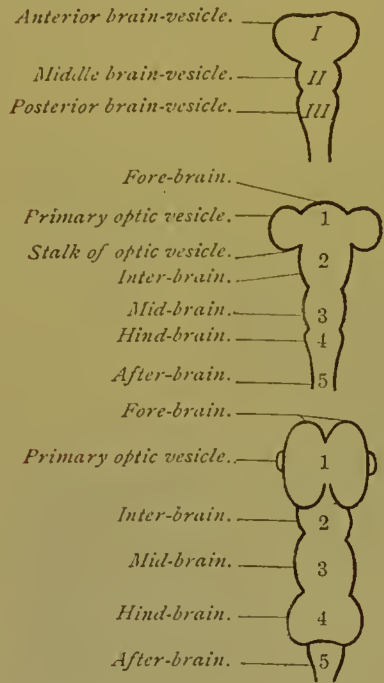


FIG. 118.—Diagrams illustrating the primary and secondary segmentation of the brain-tube (Bonnet).

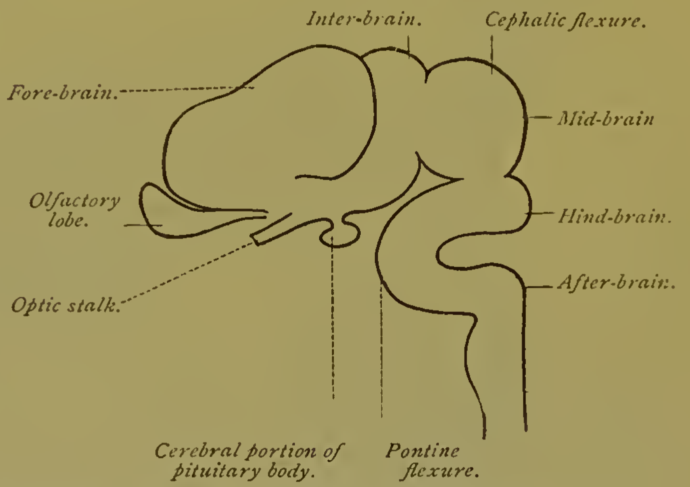


FIG. 119.—Diagram showing relations of brain-vesicles and flexures (Bonnet).

even before closure, becomes expanded into three *primary brain-vesicles*, the anterior, the middle, and the posterior. The anterior and the posterior of these vesicles very soon subdivide into *secondary* compartments, the arrangement of the brain-segments then being, from before backward, the *fore-brain*, the *inter-brain*, the *mid-brain*, the *hind-brain*, and the *after-brain* (Fig. 118).

Coincidently with these changes the cerebral axis has suffered marked deflection (Fig. 119) from its original almost straight condition. By the fifteenth day the cranial flexure is strongly pronounced, a bend of almost 90° taking place opposite the mid-brain (Fig. 120, A). During the fourth week further marked changes appear; the bend opposite the mid-brain, or *mesencephalic flexure*, has increased almost to 180°, so that the ventral surfaces of the inter-brain and the hind-brain lie nearly in contact (Fig. 120, B). The junction of the brain and the spinal cord is marked by the *cervical flexure*, which forms an angle of about 90°. A third bend, the *metencephalic* or *frontal flexure*, appears opposite the primitive cerebellum and the pons, and has its convexity directed ventrally or in a manner opposite to the disposition of the other curves (Fig. 120, C).

The development of the individual parts of the brain depends largely upon local thickenings of parts of the walls of the cerebral vesicles, whereby areas of notable thickness are produced, as in those which give rise to the corpus striatum and the optic thalamus; the cleavage of the fore-brain and the ingrowth of connective-tissue structures accompanying the growth of the primitive falx likewise exert a profound influence in shaping the parts around the lateral and third ventricles. The appearance of such commissural bands as the corpus callosum and the fornix still further modifies the adjacent struc-

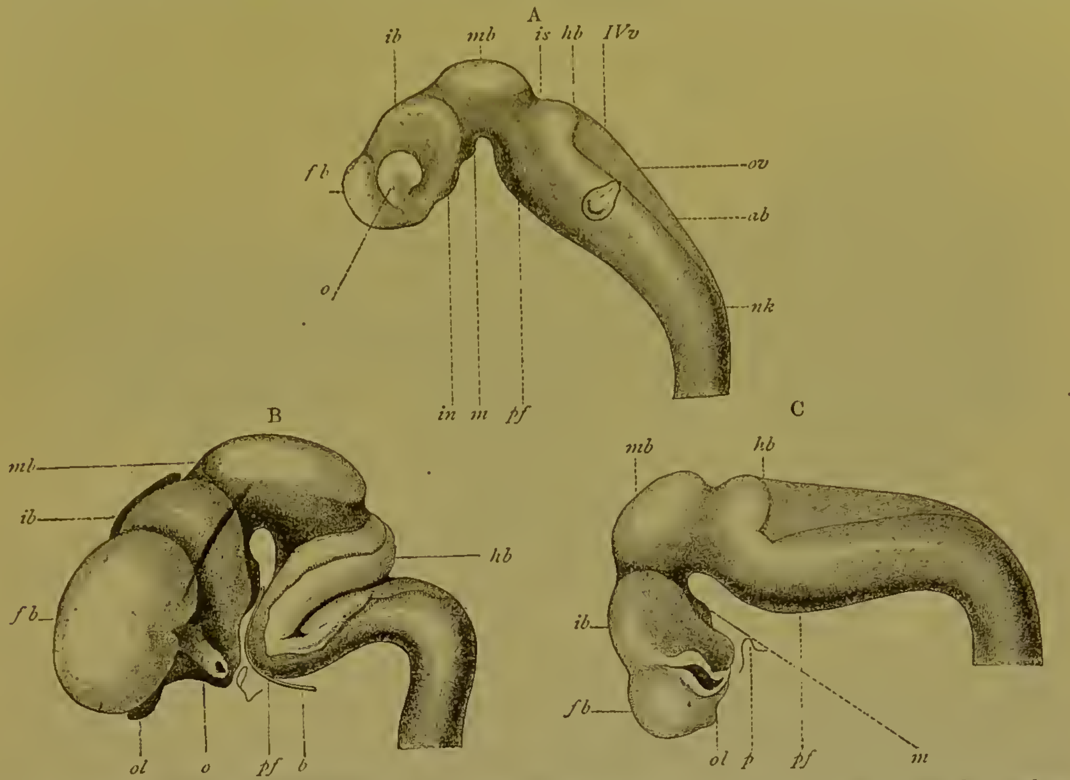


FIG. 120.—Brains of human embryos from reconstructions by His. A, brain from fifteen day embryo; B, from three and a half week embryo; C, from seven and a half week fetus: *fb*, *ib*, *mb*, *hb*, *ab*, fore-, inter-, mid- hind-, and after-brain vesicles; *o*, optic vesicle; *ov*, otic vesicle; *in*, infundibulum; *m*, mammillary process; *pf*, pontine flexure; *IVv*, fourth ventricle; *nk*, cervical flexure; *ol*, olfactory lobe; *b*, basilar artery; *p*, pituitary recess.

tures. The brain-vesicle undergoing least change is the mid-brain, since its walls remain uncleft and retain their primary relations to the enclosed canal.

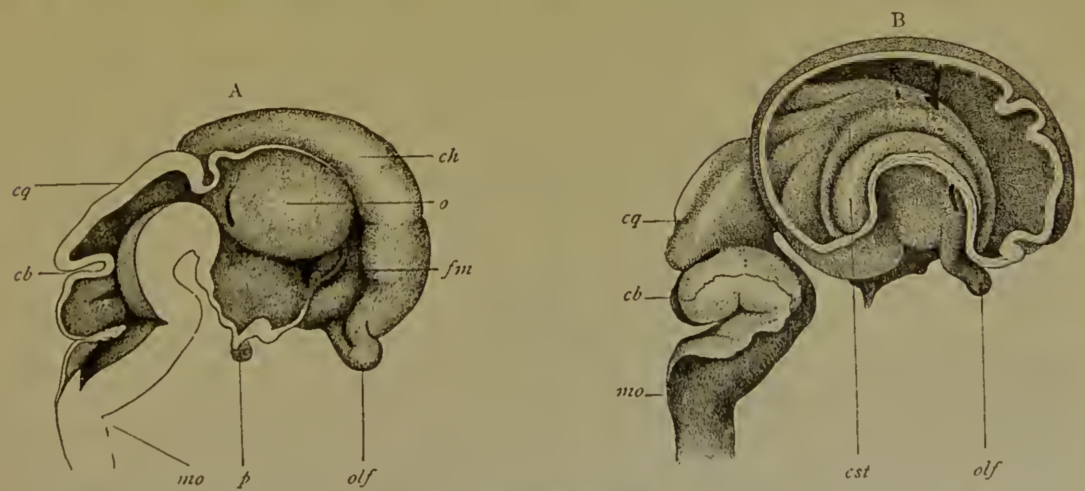


FIG. 121.—A, mesial section through brain of a human fetus of two and a half months (His): *ch*, cerebral hemisphere; *o*, optic thalamus; *fm*, foramen of Monro; *olf*, olfactory lobe; *p*, pituitary body; *mo*, medulla oblongata; *cq*, corpora quadrigemina; *cb*, cerebellum. B, brain of human fetus of three months (His): *olf*, olfactory lobe; *cst*, corpus striatum; *cq*, corpora quadrigemina; *cb*, cerebellum; *mo*, medulla oblongata.

The relative position of the mid-brain, however, undergoes great change, its original situation as the highest part of the entire encephalon being gradually appropriated by the enormously developed cerebral mantle formed by the rapid-growing cerebral hemispheres; in consequence of the covering in of the mid-brain thus effected, the derivatives of this segment, as the corpora quadrigemina, occupy a position in the base of the adult brain instead of their morphologically normal place. The extent to which the cerebral mantle

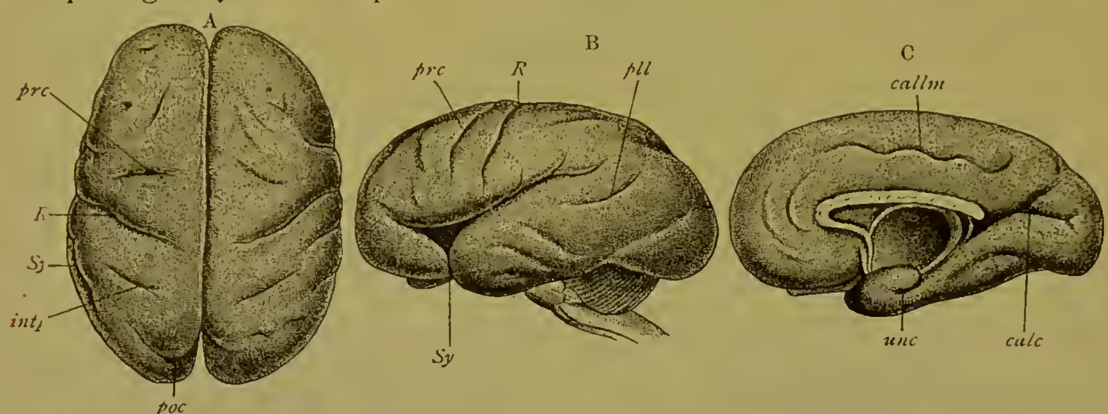


FIG. 122.—Fetal brain at the beginning of the eighth month (Mihalkovics): A, superior, B, lateral, C, mesial surface: *R*, fissure of Rolando; *prc*, precentral fissure; *Sy*, Sylvian fissure; *intp*, interparietal fissure; *poc*, parieto-occipital fissure; *pll*, parallel fissure; *callm*, calloso-marginal fissure; *unc*, uncus; *calc*, calcarine fissure.

covers the remaining parts of the encephalon, including the cerebellum, is distinctive of the human brain (Figs. 121, 122).

The inter-brain undergoes great differentiation, its derivatives forming numerous highly specialized organs, among which are the eyes and the pineal and pituitary bodies. For the complicated details of the development of the various parts of the brain the reader must be referred to the special works on embryology. The following table, however, modified from Hertwig, will serve as a general indication of the genetic relations existing between the more important parts of the encephalon and the primary cerebral segments:

DEVELOPMENT OF THE HUMAN BRAIN.

PRIMARY VESICLES.	SECONDARY VESICLES.	FLOOR.	ROOF.	SIDES.	CAVITY.	
I. Anterior primary brain-vesicle.	1. Fore-brain.	Anterior perforated spaces; olfactory lobes.	Great cerebral mantle; corpus callosum; fornix.		Lateral ventricles.	A. Brain-mantle.
	2. Inter-brain.	Optic chiasm; tuber cinereum; infundibulum; corpora mammil.	Pineal body; posterior commissure; velum interpositum.	Optic thalami.	Third ventricle.	B. Brain-stalk.
II. Middle primary brain-vesicle.	3. Mid-brain.	Cerebral peduncles; posterior perforated lamina.	Corpora quadrigemina.	Geniculate bodies; brachia.	Aqueduct of Sylvius.	
III. Posterior primary brain-vesicle.	4. Hind-brain.	Pons Varolii.	Anterior medullary velum; cerebellum; posterior medullary velum.	Superior and middle peduncles of cerebellum.	Fourth ventricle.	
	5. After-brain.	Medulla oblongata.	Thin covering of posterior part of fourth ventricle.	Inferior peduncles of cerebellum.		

The *spinal cord* is formed primarily by the thickening of the lateral wall of the neural tube, the latter becoming reduced to a narrow passage, later the central canal. At first gray matter alone exists, but with the formation of the nerve-fibres the white tracts appear (Fig. 123). The nerve-fibres connected

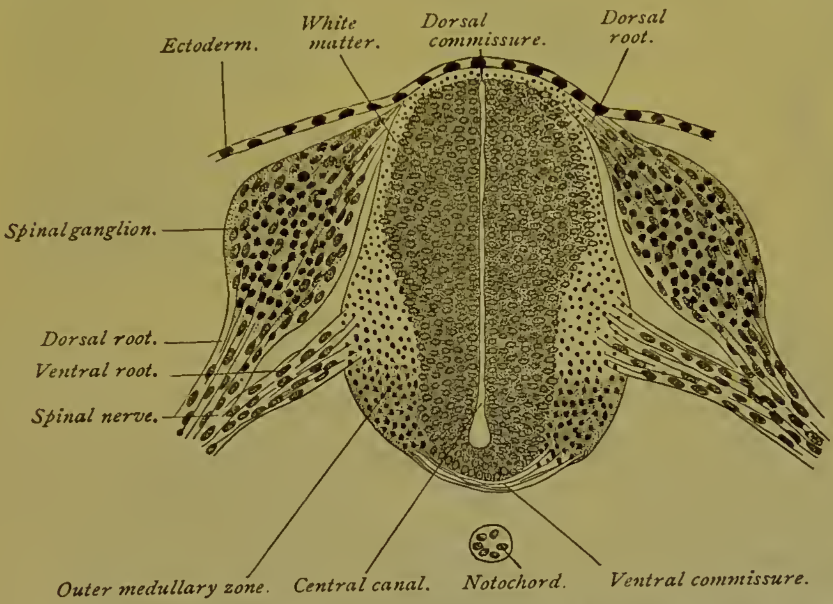


FIG. 123.—Transverse section of developing spinal cord of a twenty-two day sheep embryo (Bonnet).

with the spinal cord differ in origin according to their function whether they are motor or sensory, the former proceeding as outgrowths from the nerve-cells within the cord, the latter as processes from the cells of the spinal ganglia; these latter centres, in addition to the sensory fibres passing into the cord, send to the periphery fibres by which sensory impressions are conveyed. The *sympathetic nervous system* originates from the spinal ganglia, from which portions are separated as the organs of the sympathetic ganglia. It may therefore be accepted as an axiom that all nerve-fibres are produced as direct outgrowths from pre-existing nerve-cells, and, further, that all portions of the great nervous system may be referred to the primary neural folds.

11. **Development of the Organs of Special Sense.**—The history of the specialized organs of touch, taste, and smell, as represented by the various forms of tactile nerve-endings, such as the corpuscles of Meissner, Vater, etc., the taste-buds, and the Schneiderian mucous membrane, belongs to a consideration of the histogenesis of these structures rather than to a brief outline of salient features in general development; suffice it here to add that the organs of taste and smell consist essentially of tissue which has become specialized into neuro-epithelium, the perceptive elements consisting of modified epithelial cells bearing close relations to the nerve-fibres. The various forms of tactile corpuscles receive more or less highly developed sheaths from mesodermic tissues. The organs of sight and of hearing, on the contrary, claim greater attention on account of the profound embryological processes instituted in their formation.

The development of the *eye* consists essentially in the formation of two ectodermic epithelial pouches, the optic vesicle and the lens-sac, around which the adjacent mesoderm differentiates into vascular and fibrous envelopes. The first trace of the visual organs appears very early—at the fifteenth day—as the conspicuous optic vesicles (Fig. 128), which are formed as lateral evaginations from the hinder part of the anterior primary brain-vesicle; later, when the optic vesicle opens into the cerebral cavity by means of the optic stalk, the latter communicates with the inter-brain. The original optic vesicle soon exhibits indentation of its anterior wall (Fig. 125), the invagination progressing until the displaced layer comes in contact with the posterior and outer

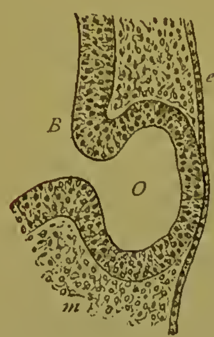


FIG. 124.—Section through head of ten day rabbit embryo, exhibiting primary optic vessel (*O*) protruding from fore-brain (*B*) and coming in contact with surface ectoderm (*e*); *m*, surrounding mesoderm (Piersol).

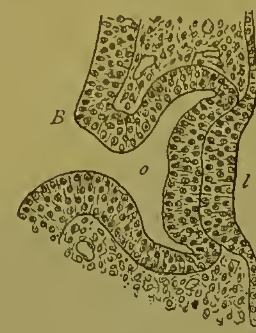


FIG. 125.—Section through developing eye of eleven day rabbit embryo (Piersol): *B*, fore-brain connected by stalk with optic vesicle (*o*), whose anterior wall is partly invaginated; *l*, thickened and depressed lens-area.

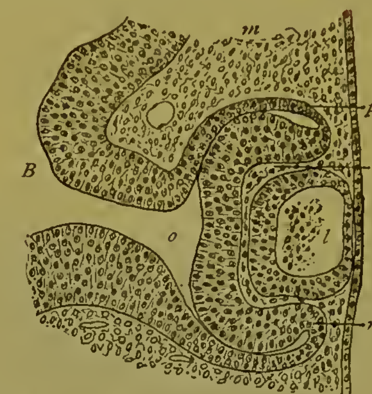


FIG. 126.—Section through developing eye of eleven and a half day rabbit embryo (Piersol): *B*, fore-brain connected with optic vesicle (*o*), nearly effaced by apposition of invaginated anterior segment (*r*) with posterior wall (*p*); *l*, lens-sac completely closed and separated from ectoderm; *t*, tissue within secondary optic cup derived from surrounding mesoderm.

FIG. 127.—Section through developing eye of thirteen day rabbit embryo (Piersol): *e*, ectoderm; *l*, lens, consisting of anterior nucleated division representing thin front wall of lens-sac, and greatly thickened posterior division completely filling cavity of sac by elongated fibres whose nuclei present crescentic zone (*z*); *p*, posterior pigmented layer; *r*, specialized anterior retinal layer; *i*, point where layers of optic vessels become continuous; *n*, extreme peripheral section of tissue of primitive optic nerve connected with vascular tunic (*v*) occupying posterior surface of lens; *m*, surrounding mesoderm, which (at *t*) grows between lens and retina.

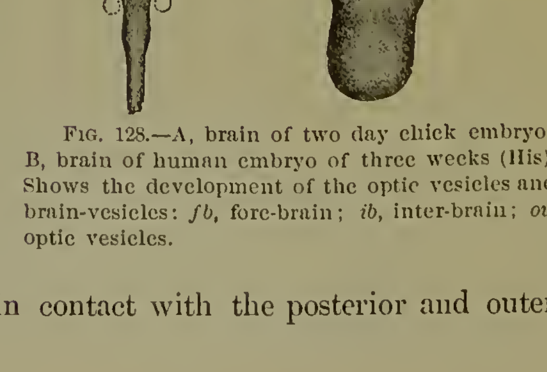


FIG. 128.—A, brain of two day chick embryo: B, brain of human embryo of three weeks (His). Shows the development of the optic vesicles and brain-vesicles: *fb*, fore-brain; *ib*, inter-brain; *ov*, optic vesicles.

undisturbed segment. The cavity of the original vesicle is now represented by the hemispherical cleft between the two layers. The cavity newly formed by the invagination of the primary vesicle becomes the *optic cup*, and represents the space later occupied by the crystalline lens and the vitreous body.

Coincidently with the changes of the optic vesicle, the surface ectoderm at first exhibits a depression lined by thickened cells; this recess or pit rapidly

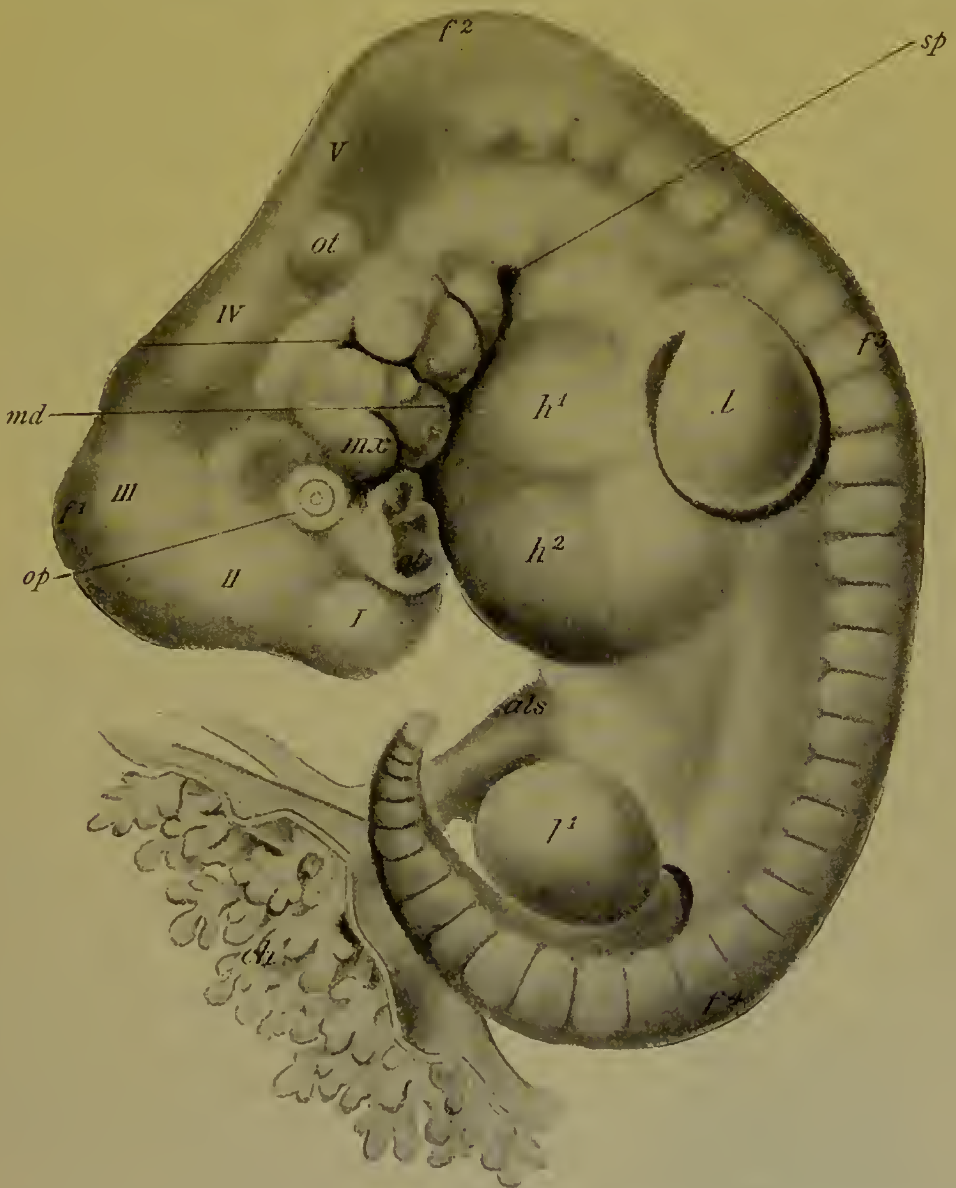


FIG. 129.—Human embryo of about twenty-eight days (His): *I–V*, brain-vesicles; f^1, f^2, f^3, f^4, cephalic, cervical, dorsal, and lumbar flexures; *op*, eye; *ot*, optic vesicle; *ol*, olfactory pit; *mx*, *md*, maxillary and mandibular processes of first visceral arch; *sp*, sinus precervicalis; h^1, h^2, heart; l, l^1, limbs; *als*, allantoic stalk; *ch*, villous chorion.

deepens and expands, and finally becomes the closed and isolated lens-sac, lying within the mouth of the optic cup, which it largely fills (Fig. 126).

The fate of the layers composing the optic cup, briefly stated, is the formation of the various parts of the retinal tract, the outer and posterior layer becoming the characteristic sheet of retinal pigment; the blood-vessels and the connective-tissue elements of the retina are secondary ingrowths (Fig. 127). The hinder wall of the lens-sac undergoes great proliferation, growth, and thickening, and eventually fills the entire sac, the lens then continuing as a solid body composed of specialized epithelial elements.

The surrounding mesoderm contributes the blood-vessels, the vitreous body, the choroid, and the sclerotic coat, including the iris and the cornea with the exception of the anterior epithelium of the latter, which is ectodermic in origin. The eyelids, which appear toward the end of the second month, are developed as duplicatures of skin above and below the eye; about the end of the third or the beginning of the fourth month the lids meet and unite, the eyes remaining closed until near the end of gestation, when the lids permanently separate.

The *ear* includes several distinct developmental processes, since the genesis of the auditory apparatus of man includes the formation of the external, the middle, and the internal ear.

The *external ear* is closely related to the history of the first outer visceral furrow, the external canal being, with some minor variations, the representative of this cleft, and the expanded parts constituting its pinna, resulting from the fusion and metamorphosis of the *auditory tubercles* (Fig. 129) surrounding the outer end of the visceral furrow.

The *middle ear* is formed by the persistence and further expansion of the first pharyngeal pouch, hence possesses an entodermic lining. The tympanic membrane includes contributions from all three layers, its outer epithelium being ectodermic, its inner epithelium entodermic, and its fibrous tissue mesodermic, in origin.

The *internal ear* consists of the morphologically older ectodermic portion, which is represented by the complicated membranous labyrinth, and the surrounding mesodermic envelope, which becomes the bony capsule, and the connective-tissue structures included between the osseous and the membranous labyrinth.

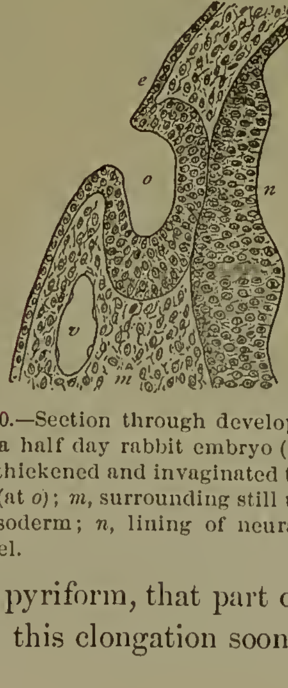


FIG. 130.—Section through developing ear of nine and a half day rabbit embryo (Piersol): *e*, ectoderm thickened and invaginated to form auditory pit (at *o*); *m*, surrounding still undifferentiated mesoderm; *n*, lining of neural tube; *v*, blood-vessel.

The earliest appearance of the ears takes place about the fifteenth day, when on each side of the hind-brain a depression lined by thickened ectoderm (Fig. 130), the *otic pit,* is formed. Almost immediately these pits become converted into sacs, the *otic vesicles,* by the closure of their mouths, and soon lose all connection with the ectoderm, lying entirely surrounded by mesodermic tissue some little distance beneath the free surface. The otic vesicle appears pyriform, that part corresponding with the closed mouth becoming extended; this elongation soon becomes more pronounced, so that the now somewhat flattened sac presents a conspicuous outgrowth, the *recessus labyrinthi* (Fig. 131, A).

The otic vesicle assumes greater irregularity on account of the appearance, during the fifth week, of a blunt diverticulum, anteriorly and ventrally directed, which is the earliest trace of the future membranous cochlea, and, shortly after, of dorsal projections on its outer side, which foreshadow the semicircular canals (Fig. 131, B, C). Before the end of the fifth month, the chief compartment of the vesicle, by this time of considerable size, undergoes

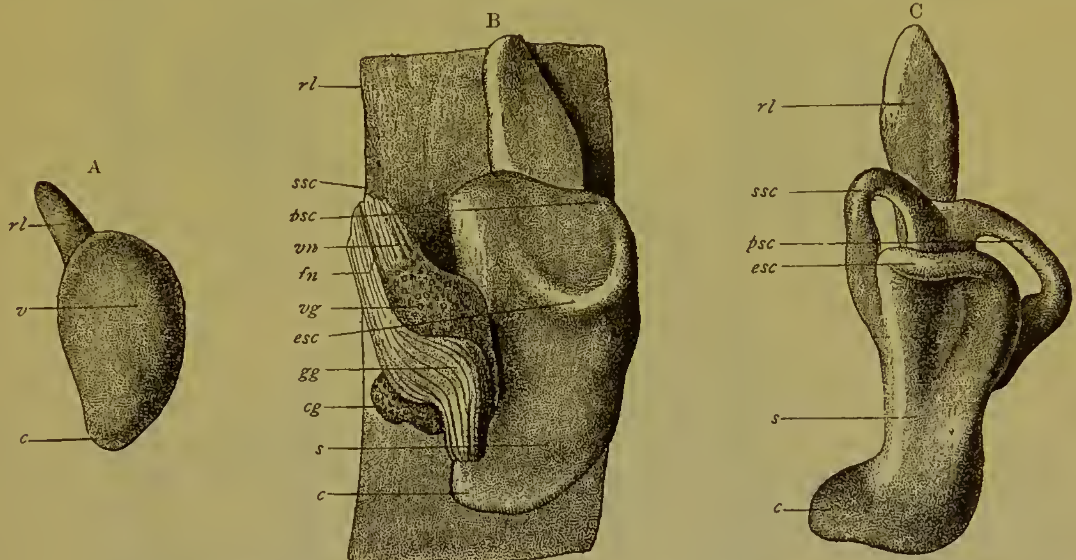


FIG. 131.—Development of the membranous labyrinth of the human ear (W. His, Jr.). A, left labyrinth of embryo of about four weeks, outer side: *v*, *c*, vestibular and cochlear portions; *rl*, recessus labyrinthi. B, left labyrinth with parts of facial and auditory nerves of embryo of about four and a half weeks: *rl*, recessus labyrinthi; *ssc*, *psc*, *esc*, superior, posterior, and external semicircular canals; *s*, saccule; *c*, cochlea; *vn*, *fn*, vestibular and facial nerves; *vg*, *cg*, *gg*, vestibular, cochlear, and geniculate ganglia. C, left labyrinth of embryo of about five weeks, from without and below: labelling as in preceding figure.

subdivision by the formation of a constricting fold into a dorsal division, the primitive *utriculus*, and a ventral division, the primitive *sacculus*. The rudimentary semicircular canals and the primitive cochlear duct open respectively into the utricle and the saccule. The recessus labyrinthi has become meanwhile greatly elongated, and its proximal end cleft into diverging tubes at the formation of a septum. These limbs of the recess open into different spaces, one entering into the saccule, the other into the utricle.

The permanent arrangement is now established whereby communication between the divisions of the membranous vestibule, the utricle and the saccule, is effected only by the indirect passage through the limbs of the ductus endolymphaticus. The primary otic vesicle thus becomes the complicated membranous labyrinth, and the ectodermic epithelial lining undergoes differentiation in the formation of the highly specialized structures, as the organ of Corti and the maculæ acusticæ, for the perception of transmitted stimuli.

The mesoderm immediately surrounding the membranous labyrinth later undergoes important changes, whereby the tissue next the epithelial structures is converted into the connective tissue enveloping and supporting the delicate

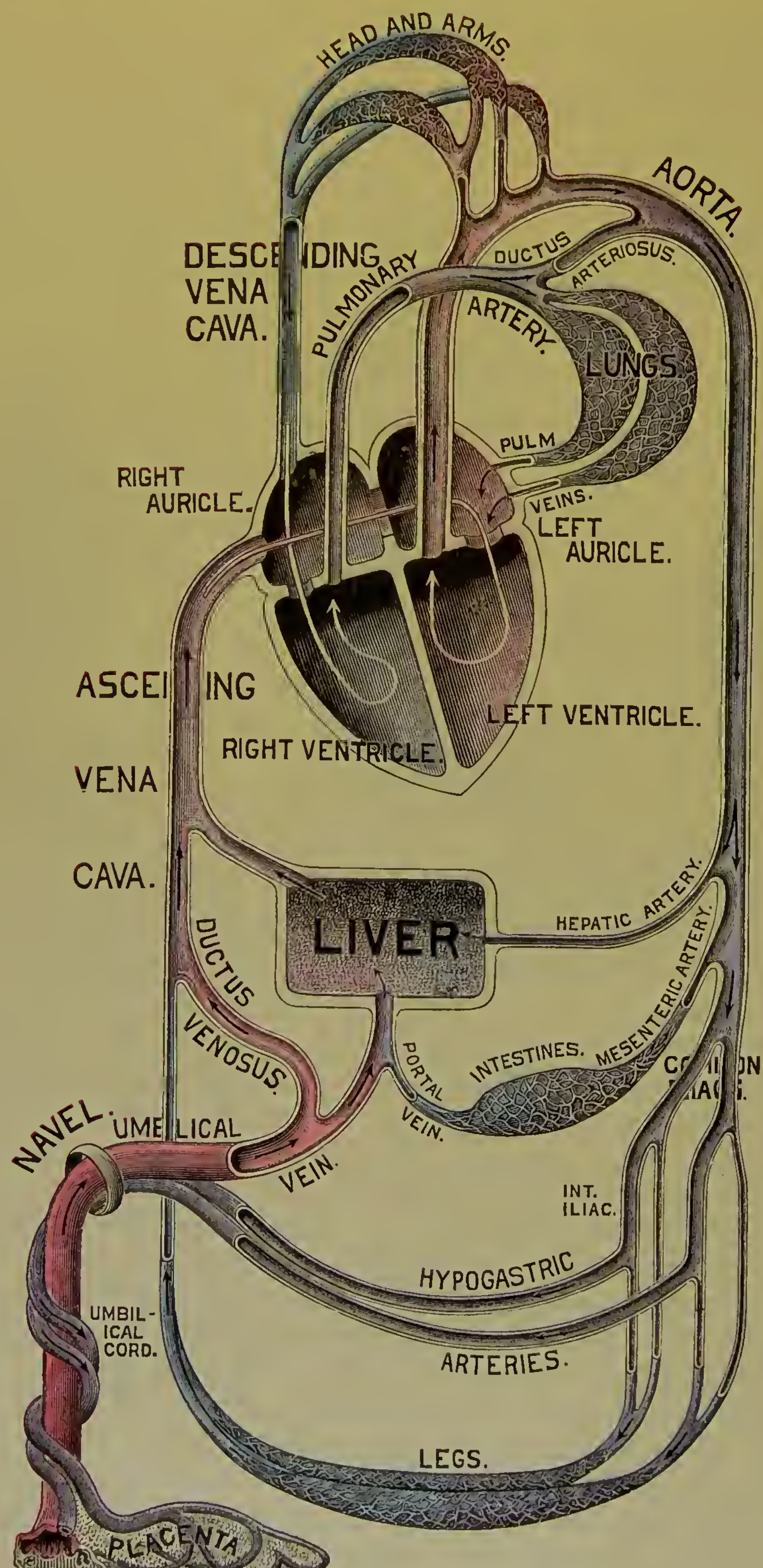


FIG. 132.—Diagram of fetal circulation before birth; the arrows indicate the course of the blood-current; the colors show the character of the blood carried by the different vessels.

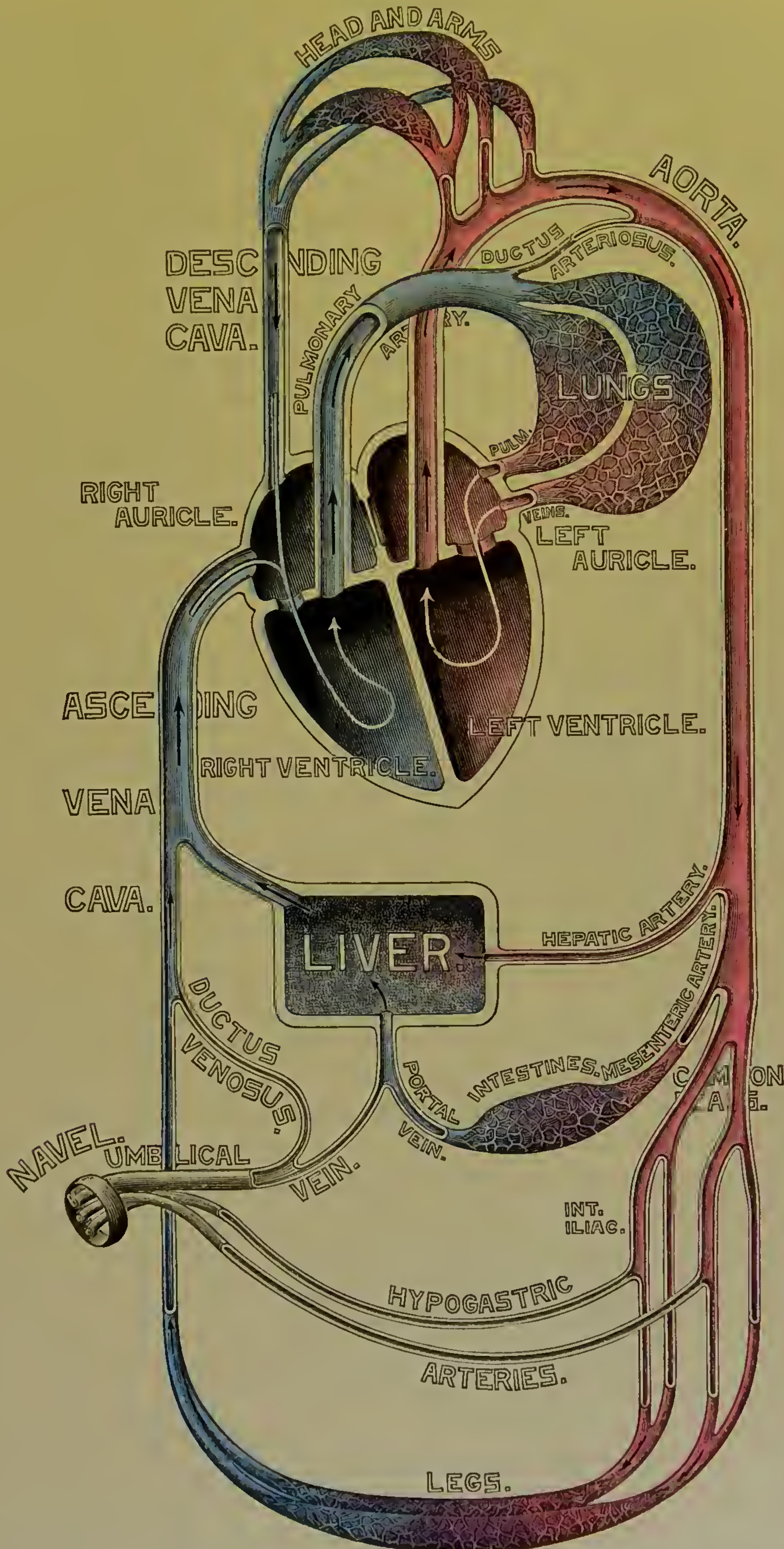


Fig. 133.—Diagram of circulation after birth; the ductus venosus, the foramen ovale, and the ductus arteriosus are now closed and no longer transmit portions of the blood-current.

epithelial labyrinth, while the tissue slightly removed gives rise to the periotic cartilaginous capsule which later is replaced by bone. The important spaces occupied by the perilymph are formed relatively late, since they arise by the breaking down and channelling of the mesoderm surrounding the epithelial tubes. In the cochlea, for example, the ductus cochlearis, with its epithelial lining, represents genetically the oldest part, while the scala vestibuli and the scala tympani are of more recent origin, since they are formed by partial disappearance of the mesodermic tissues.

2. Physiology of the Fetus.

Nutrition and Growth.—It is evident that the life of the ovum, whatever its character, whether vertebrate or invertebrate, picean, amphibian, reptilian, avian, or mammalian, can only be maintained when the fundamental necessities of life—adequate supplies of oxygen, water, and suitable nourishment—are provided. The ovum and the early embryo being without means of securing these advantages, such provisions must be ensured by the arrangement of the immediate environments, whether these be within the maternal tissues or within the protecting structures of the shell or the surrounding medium.

The loss of yolk, which there is good reason for believing the mammalian ovum has suffered during its evolution, is compensated by the nutritive materials supplied to the developing ovum by the adherent discus proligerus, and by the secretions of the oviduct and uterus which are taken into the interior of the egg by osmosis through the zona pellucida and the primitive chorion.

The Fetal Circulations.—The earliest circulation, the vitelline (Pl. 15), is well established during the third week. The blood passes from the network of the vascular area, by means of the large vitelline or *omphalo-mesenteric veins*, into the sinus venosus, and then, after mingling with the blood returned by the systemic veins from the body of the embryo, into the auricular segment of the young heart. From the anterior or arterial end of this organ the blood is carried by the *truncus arteriosus* into the aortic arches, hence into the primitive aortæ, a small portion passing into vessels supplying the embryo, while the greater part enters the vitelline arteries and once more gains the vascular area.

The development of the allantoic vessels and the placental circulation necessitates additional blood-currents, in the direction of which the now rapidly developing heart and liver exert an important influence. For a time all the blood returning from the placenta passes through the liver before reaching the heart; later, when the hepatic capillaries can no longer accommodate the entire placental circulation, the *ductus venosus* is established.

During the later months of gestation the so-called "fetal circulation" (Figs. 132, 133) presents the following details: After purification by the respiratory interchanges carried on within the placenta by association with the maternal circulation, the blood is conveyed by the single umbilical vein to the under surface of the liver; here the current divides, one part joining the venous blood within the portal vein collected from the intestines, and traversing the hepatic capillaries to reach the hepatic veins, the other part passing into these vessels directly by means of the ductus venosus. On reaching the inferior cava the arterial placental blood, but slightly contaminated by admixture of the contents of the portal vein, is poured into the stream of venous blood returned by the inferior cava from the lower parts of the body, and is carried into the heart as part of the mixed stream. On entering the right auricle a fold, the Eustachian valve, directs the blood brought by the inferior cava across the auricular cavity through the foramen ovale into the left auricle. Mingling with the small quantity of blood returned from the uninflated lungs by the pulmonary veins, the blood-current passes through the auriculo-ventricular opening into the left ventricle, by the contractions of which it is propelled into the aorta, and distributed by the branches of that vessel to all parts of the body.

The blood gathered from the head and the upper extremities and returned to the right auricle by means of the superior cava passes directly through the auricle and right auriculo-ventricular orifice into the right ventricle, crossing in its course the blood-stream entering by the inferior cava. The contractions of the right ventricle send the blood thus returned by the superior cava into the pulmonary artery and on to the lungs. These organs, being still uninflated, are incapable of receiving more than a small part of the blood supplied from the ventricle; the excess, however, is carried by means of a newly-formed channel, the *ductus arteriosus,* which extends from the beginning of the left pulmonary artery to the aorta. The blood carried through this canal mingles with that descending the aorta; on reaching the hypogastric arteries a large part of the current passes to the placenta for oxygenation, only a small proportion of the stream continuing within the systemic arteries for the supply of the lower parts of the trunk and the inferior extremities. It will be noticed that after joining the current within the inferior vena cava the blood circulating within the fetus is nowhere purely arterial, but is always contaminated by the admixture of blood already distributed to other parts.

The distinctive features of the fetal circulation are the ductus venosus, the ductus arteriosus, the foramen ovale, the hypogastric arteries, and the umbilical vein. After birth, with the establishment of the respiratory function and the pulmonary circulation, the accessories to the arrangement of the placental blood-current undergo atrophy and largely disappear. While immediately instituted, these changes are not fully effected until some time after birth. Obliteration of the distal parts of the hypogastric arteries first occurs, and is usually completed by the third or the fourth day after birth. The ductus venosus and the umbilical vein are generally closed by the end of a week. The ductus arteriosus usually closes within a few days, and is completely impervious by the third week after birth. Permanent closure of the foramen ovale is delayed for some time, the blood being excluded from the left auricle by the apposition of the edges of the valve, which are kept in place by the increasing pressure from the left side exerted by the blood returning from the lungs. After a time the edges of the valve coalesce with the margin of the foramen ovale and the opening becomes permanently closed; not infrequently, however, months elapse before the union becomes complete. In case this union is never perfectly effected, a small communication may remain throughout life as a congenital defect, of slight or grave import depending upon the extent of the faulty union.

The establishment of the vitelline circulation, the first one of the embryo, marks the introduction of an important nutritive apparatus in animals possessing large yolks, which in them constitute sources of nourishment of great consequence. In man and other mammals, however, the appearance of the vitelline circulation must be regarded rather as the expression of formative processes whose usefulness has largely disappeared in consequence of the profound modifications which the diminution of yolk and the greater dependence on the maternal tissues have witnessed. While in mammals the exposure of the fetal blood-stream over the extended walls of the vitelline sac or umbilical vesicle affords an opportunity for a limited exchange of gases, the amount of nutritive materials directly taken up and appropriated by the embryo must be very insignificant.

The deficiencies of the vitelline circulation in mammals, however, are compensated by the active development of the allantoic vessels and their further specialization into the all-important placental circulation, whereby the respiratory and nutritive necessities are secured to the fetus throughout the last two-thirds of gestation.

The placental circulation, by means of which the respiratory interchange of gases and the passage of nutritive substances from the maternal blood to that of the fetus is effected, is undoubtedly the principal, and practically the sole, source of those substances necessary to maintain the life of the developing animal. The *liquor amnii* has long been regarded as an additional source of nutritive materials, in view of the fact that this fluid is undoubtedly swallowed by the embryo and taken into its intestinal canal, as shown by its presence, as well as the presence of hairs and epidermal cells at a later stage, within the gut. The composition of this fluid, however, renders it highly improbable that it contributes in any appreciable degree to the nourishment of the fetus, containing as it does nearly 99 per cent. of water. The liquor amnii, nevertheless, serves an important purpose in supplying the water necessary for the fetal tissues, since the latter must contain water in excess, according to Preyer, in order to extract the albumen and the salts from the blood brought by the umbilical vein.

The fetal placental vessels convey albumen, salts, and water from the maternal blood into the circulation of the fetus, as well as the oxygen absorbed by the red blood-cells during their sojourn in close proximity to the sinuses filled with the blood of the mother. The soluble salts probably pass from the maternal blood into the fetal blood by simple osmosis. That the albuminous substances, however, are so transferred is very doubtful, but the solution of this question, it must be admitted, so far has been unsatisfactory. The ingenious explanation advanced by Rauber, that a physiological transmigration of leucocytes from the maternal tissues into the fetus furnishes the means of transportation of particles of albumin, fat, lecithin, and similar substances, lacks confirmation. By some the evidence is regarded as strong that they pass over in the form of soluble peptones.

That substances in solution pass from the maternal circulation into that of the fetus has been proved by direct experiments with iodin (Gusserow, Krukenberg, Haidlen), salicylic acid (Benicke), and potassium ferrocyanid (Fehling). The investigations of Zweifel demonstrated the free and rapid passage of chloroform administered during parturition from the maternal blood into the umbilical circulation, and, consequently, the highly probable influence of the anesthetic upon the fetus. The result of attempts to introduce substances in a condition of fine division, but not in solution, such as vermilion, India ink, fat, etc., have been negative, the seeming exceptions where such particles were found in the fetal circulation after injection being attributable to injury of the blood-vessels.

The migration of formed elements, such as the pathogenic bacteria of anthrax, typhus, etc. or the colorless blood-corpuscles, from the circulation of the mother into the fetal blood is a question about which there is much difference of opinion. Regarding the blood-cells, moreover, the investigations of Sänger point to the improbability of such migration taking place, since in leukemic conditions of either mother or child the blood of the remaining organism may retain its normal proportions. The experiments of Savory and Gusserow have shown that in animals in which the fetus is poisoned by strychnia the poison may pass from the fetal circulation into that of the mother.

Certain substances administered to the mother pass into the liquor amnii, as in the case where iodin is given (Krukenberg). That the fetus takes no part in producing this effect is shown by the fact that the drug is found in the liquor amnii even when the product of conception is dead (Haidlen); further, that coloration of the amniotic fluid after the injection of sodium sulphindigotate into the jugular vein of the mother is unattended by the presence of the substance within either the kidneys or the urine of the fetus (Zuntz). The staining of the maternal tissues composing the decidua by the pigments contained within the meconium emphasizes the fact that substances within the liquor amnii may in turn affect the mother.

The respiratory and metabolic changes within the fetus are carried on by means of the oxygen taken up from the maternal circulation by the fetal blood-stream in its passage through the placenta, in exchange for the carbonic acid and other products of tissue-change. So long as this interchange of gases takes place without interruption in the placenta, the fetal circulation contains an excess of oxygen, since, notwithstanding the small amount derived from the mother, the quantity of this gas thus obtained more than suffices for the needs of the embryo, and induces a condition of apnea. When the placental circulation is interrupted, however, as by compression of the umbilical cord or by premature separation of the placenta, the fetus perishes with all the symptoms of asphyxiation.

The direct proof of the source of oxygen from the placenta has been supplied by the investigations of Cohnstein and Zuntz, who examined the blood of the umbilical vein in sheep, and found it richer in oxygen than that within the umbilical arteries, although the difference between the arterial and the venous blood during intra-uterine life is much less marked than after birth (Halliburton). The spectroscopic analysis of blood from the human umbilical vessels by Zweifel showed the presence of the oxyhemoglobin bands before respiration was established.

The consumption of oxygen by the fetus, as measured by the necessities of its own heat-production, is relatively small, since the maintenance of its temperature is greatly facilitated by being surrounded by the liquor amnii, the warmth of which is almost equal to that of the fetal blood. The fetus is still further favored by being spared the necessity of taking within its lungs and alimentary tract substances which must be warmed to its own temperature at the expense of its own heat. The presence of the warmed liquor amnii also prevents caloric loss by either radiation or evaporation.

The pre-natal functions of the fetus include limited activity of the kidneys and preparatory exercise of the organs and glands connected with the alimentary tract and the integument.

The early excretory apparatus of the embryo is represented by the Wolffian bodies and their ducts and the allantois. The yellowish fluid collected within the allantoic sac after its secretion by the Wolffian bodies cannot be regarded as urine in the strict sense of the term, since its elaboration long precedes the development of the fetal kidneys. There is, however, a similarity between the usually alkaline allantoic fluid and the later secretion of the fetal kidneys, the fluid often, but not invariably, containing urea, uric acid, the alkaline chlorids, phosphates, and sulphates, as well as iron, calcium carbonate, and allantoid. The early presence of urea and the urates renders it highly probable that the decomposition of albumin with oxidation begins at an early period of intra-uterine life, the excreted substances being taken from the still imperfectly differentiated fetal blood.

The question whether the kidneys under normal conditions regularly secrete urine before birth has received much attention and various answers. The weight of evidence undoubtedly establishes the exercise of such function, but exactly the period at which the secretion of urine first takes place is still undetermined. After the establishment of communication between the bladder and the exterior of the body by the formation of the urethral canal, the urine is discharged, during the later weeks of gestation, into the amniotic fluid, with which it is in part swallowed by the fetus. The coloring matters of the urine are elaborated only in very limited quantities, as shown by the well-known pale tint of the fluid voided by the new-born child.

Digestive Tract.—The pre-natal activity of the glands connected with the fetal alimentary tract is a matter of much interest in view of the demands made upon these organs immediately after birth to supply the ferments necessary in the process of digestion and assimilation. The inherent difficulties attending the investigation of the subject in the human fetus have left our knowledge on many points still far from satisfactory.

The saliva of the fetus has received much attention with a view of determining the presence or absence of ptyalin. While the results of the observations by various investigators are contradictory, the positive evidence of the presence of this ferment in the saliva of the new-born obtained by Schiffer is important. This observer demonstrated the unmistakable presence of ptyalin in the salivary secretion of three new-born children, thus showing that the capability of converting starch into sugar exists in the saliva from birth—a fact the more remarkable when the absence of the opportunity for the exercise of this power is recalled, the character of the early food requiring neither starch nor dextrin. It has been shown that the ptyalin is not elaborated indifferently by the salivary glands, but that its presence is limited to the secretion and tissue of the parotid. The relatively tardy development of the labial and other glands of the oral cavity is in accord with the observed slight activity of the secretory function of the mouth of the fetus.

The gastric secretions of the new-born have been found to contain pepsin and rennin immediately after birth, pepsin digestion and the power of curdling milk being established within a few hours. The observed differences in the amount of pepsin contained in specimens of the mucous membrane of new-born children probably depend upon the variability in the development of the gastric glands, as pointed out by Sewall.

The pancreatic ferments are probably represented before birth by the presence of *trypsin*, which acts especially upon the proteids, and a fat-splitting ferment (*pancreatin, steapsin*), but not by *amylopsin*, which resembles ptyalin in possessing the power of attacking starch. Langendorff demonstrated the presence of trypsin in the pancreas of the fetus at the fifth and sixth month; Zweifel, that of pancreatin at birth. The large amount of fatty and albuminous matters in the milk at once suggests the necessity of the early preparation of the digestive ferments required for the disposition of these substances.

The intestinal secretions at birth differ widely from those of a slightly later period. In this respect the observation of Werber, showing the relatively larger number of Brunner's glands in the new-born than during later life, is of interest, although the function of the glands within the fetus is not obvious.

The liver early develops, and soon becomes the most conspicuous organ connected with the fetal digestive apparatus. Its large size suggests an early activity, which, in fact, observations on mammalian embryos confirm. A substance resembling bile has been found in the small intestines from the third to the fifth month, and later in the large gut; in this material, from fetuses of the third month, Zweifel found the bile-acids and the biliary pigments.

The meconium, the contents of the fetal intestinal canal at birth, presents a dark, brownish-green or almost black appearance, and a soft, viscid, pitch-like consistence. Its source has been the subject of interesting investigation, but much relating to its origin still remains to be investigated. The production of meconium seems chiefly related to the formation of bile, since it is absent before this secretion is poured into the intestinal canal, as well as in cases of malformation in which the elaboration of bile is wanting. The view attributing to the swallowed liquor amnii an active *rôle* in the formation of the meconium is opposed by the presence of this substance in malformed fetuses in which the possibility of entrance of the amniotic fluid into the intestines was precluded.

Before the secretion of bile meconium is not present. Hennig observed light yellowish-green meconium in a fetus at the beginning of the fourth month. The beginning of the fifth month usually marks the period from which the meconium is constantly present. This substance, in addition to the bile, consists of the unabsorbed portions of the intestinal mucus and juices, the secretions of the glands of Brunner and of the pancreas, and of the swallowed amniotic liquid, together with such remains as leucocytes, intestinal epithelium, lanugo, epidermal cells, and fat from the vernix caseosa carried into the gut-tract along with the liquor amnii.

The chemical composition of meconium, as ascertained by Zweifel, includes from 20 to 27 per cent. of solids, of which about 1 per cent. is inorganic, the remainder organic; the amount of fat and fat-acids and of cholesterin is the same—about .75 per cent. The inorganic constituents include the phosphates and sulphates of magnesium and calcium, sodium chlorid, and oxid of iron. The principal organic substances are the more or less changed bile-salts, the unaltered bile-pigments, bilirubin and biliverdin, and mucin.

3. Multiple Conceptions.

The fecundation of more than a single ovum, or, as often less accurately termed, "multiple pregnancy," is by no means an infrequent occurrence, as the numerous births of two or more children testify. Multiple conceptions may result in the birth of twins, triplets, and, as great rarities, quadruplets; a number of well-authenticated instances of five children at one time are recorded; and even an apparently trustworthy case of the birth of six, four boys and two girls, has been reported by Vassalli. The reputed births in excess of this number are apocryphal.

The most extensive series examined with a view of determining the relative frequency of multiple conceptions is that studied by G. Veit, which included the records of thirteen million births in Prussia. According to these statistics, twins occur once in 88 births; triplets, once in 7910; and quadruplets, once in 371,126. About a dozen authentic cases of five at a birth are recorded in medical literature (Kaltenbach). The statistics of different countries seemingly point to considerable variations in the frequency of twins; thus, in Bohemia twins occur once in about 60 births, while in France they appear only once in every 100. Recent statistics supplied by the Board of Health of New York and of Philadelphia place the frequency of twin births in these cities at 1 in every 120 births. In accepting such conclusions, however, possible errors arising from differences in the character and completeness of the statistics compared must not be overlooked.

Of 150,000 twin pregnancies studied by Veit, in one-third both children were boys; in slightly less than one-third both were girls; and in the remaining third both sexes were represented. Twins are more frequent in multiparæ than in primiparæ. Individual and inherited tendencies seem also to be factors in the occurrence of multiple conceptions, since plural births sometimes render particular women or certain families conspicuous.

Twins usually develop from two distinct ova derived from the same or from different Graafian vesicles, which may be separated widely or which may even be contributed by different ovaries, as shown by the presence and location of the corpora lutea. When derived from a single ovum, the existence of a double germ may be assumed, with, however, the possibility borne in mind that the twins may have arisen as the result of complete fusion of a single germ, as emphasized by Ahlfeld in his investigation of the production of double monsters. Twins originating in this manner are termed "homologous" and are characterized by remarkable physical and mental similarity. Of 506 cases of twins, Ahlfeld found but sixty-six proceeding from a single egg. Twins derived from a single ovum are always of the same sex; those from two ova may be of different or of the same sex.

The arrangement of the fetal membranes of twins depends upon the mode of their origin. The decidua vera is always simple; the decidua reflexa, on the contrary, is double when the ova become attached to widely separated parts of the uterine wall. The chorion, being primarily derived from the zona pellucida, is single when the twins originate from two germs contained within a single ovum, but double when they arise from separate eggs. The amnion is primarily always single, since this membrane is produced as an outgrowth and extension of the embryo itself. In those cases where twins occupy a common amniotic sac, a secondary fusion of the two originally distinct sacs has occurred by the breaking down and absorption of the septum which for a time separated them.

The placenta is at first double, since each fetus forms its own allantois and resulting placental area. When the twins originate from different ova the placenta may remain permanently distinct, but even in such cases fusion of the placental areas eventually takes place. The placental vessels of single-egged twins almost invariably anastomose, so that the placentæ become more or less completely fused, the common nutritive area then consisting of three parts, an intermediate, indifferent area being enjoyed in common, in addition to the particular part which ministers especially to each fetus (Hyrtl). The anastomosis of the placental vessels may result in the most profound impressions in those cases where marked differences exist in the development and vigor of the two fetuses, since the circulation of the weaker fetus may be unfavorably influenced, even to the extent of reversal (Ahlfeld), by the overpowering force of that of its stronger brother. Disastrous atrophy and the production of an acardia are among the results attributable to such conditions.

When one fetus succumbs, the pressure exerted during the growth of the iving child gradually reduces the mass of the dead product of conception, until finally it is represented by the greatly flattened and attenuated remains imprisoned against the uterine walls, then constituting the "fetus papyraceus" of the teratologist. Conspicuous, and sometimes remarkable, disparity in the perfection of growth and development may exist in twins at birth, the more favored fetus sometimes exceeding the smaller threefold in weight, the difference depending upon the nutritive advantages enjoyed by the one at the expense of its less fortunate fellow. In consequence of this disparity it sometimes, though very rarely, happens that the fully-matured fetus is expelled at term, while the still imperfectly developed fetus is retained for a time within the uterus until its development has progressed farther toward completion, when it in turn is born. Two remarkable cases in which double uteri were present have been recorded by Barker and Generali, where intervals of forty-three and thirty days respectively intervened between the births of the two fetuses. It is the occurrence of such cases which is erroneously regarded as a fact in support of the possibility of superfetation.

Triplets may originate, it is evident, from a single ovum or from two or three distinct eggs, a frequent arrangement being that one child is derived from a distinct ovum and two from a single ovum. Upon the manner of their origin depend the arrangement and relations of the placenta and membranes. Quadruplets may exist as double twins, or they may result from a combination of a single birth with triplets.

Plural conceptions, on the one hand, may result from a single coitus, whereby are impregnated ova which have simultaneously been discharged from the sexual gland, prepared for the reception of the male elements; on the other hand, repeated impregnations may occur after different, though closely following, sexual acts, these resulting in the fecundation of different ova which have been liberated at slightly separated moments, but which belong to the same ovulation. This possibility has received recognition in the term *superfecundation* or *superimpregnation*, by which is understood the fecundation of two ova, belonging to the same period, by different sexual acts. Conspicuous examples of such occurrences are afforded by instances where a negress gives birth to a white and a black child.

While the occurrence of superimpregnation is undisputed, *superfetation*, or the possibility of ova which originate from different ovulation periods, and therefore liberated at considerable intervals, being impregnated by sexual acts widely separated, is not admissible. While instances of the delayed birth of a second child are adduced in support of the recognition of the possibility of superfetation, the obvious physical impossibilities of the assumed occurrence are unanswerable objections to the validity of such interpretation. When the rapid and important changes in both the ovum and its environment that follow fecundation are recalled, the impossibility of spermatozoa reaching and impregnating an additional ovum on the one hand, and of the ovum, even although fecundated, descending the Fallopian tube to the uterus, on the other hand, is manifest. The cases cited in support of superfetation are all explicable from the well-known facts attending the unequal growth and development of twin conceptions, where this disparity results in the delayed delivery of the less favored fetus.

Plural births frequently occur before term, twins being born a few weeks before the end of gestation, quadruplets and quintuplets in the earlier months of pregnancy.

4. Changes in the Maternal Organism Induced by Pregnancy.

1. Local Changes.—The presence of the fecundated ovum inaugurates a season of increased nutritive energy, which not only effects changes in those organs in immediate relations with the developing fetus, but also induces changes involving the entire organism of the mother during the continuance of pregnancy. The changes thus induced in the general system being discussed in a separate section (p. 153), consideration in the present place will be directed to those changes manifested by the sexual organs and the parts intimately connected with the processes of gestation and parturition.

The uterus, as may be expected from its especial relation to the developing fetus, early manifests the profound changes which it undergoes; indeed, the preparatory alterations affecting its mucous lining and vascularity preceding each menstrual epoch must be regarded as the beginning of the cycle of changes that ends only with the return of the organ to its normal condition after the expulsion of the product of conception and the protecting structures.

The hypertrophy of the mucous membrane of the uterus and the greatly increased vascular supply which take place coincidently with the liberation of the ripe ovum from the ovary, under usual conditions, are succeeded by the destructive changes giving rise to the phenomena of menstruation. Should impregnation, on the contrary, occur, the hypertrophic processes are continued with increased vigor, and result in the alterations already described in connection with the formation of the decidua (p. 86).

The most conspicuous consequence of the changes in the uterus is the notable increase in the size and weight of this organ. From the insignificant dimensions of the small, rigid virgin uterus, which include a length of 7 centimeters ($2\frac{3}{4}$ inches), a breadth of 4.5 centimeters ($1\frac{3}{4}$ inches), and a thickness of 2.5 centimeters (1 inch), there is developed a huge flaccid sac which measures at the close of gestation from 37 to 38 centimeters ($15\frac{1}{4}$ inches) in length, 26 centimeters ($10\frac{3}{8}$ inches) in breadth, and 24.4 centimeters ($9\frac{3}{4}$ inches) in thickness, with a circumference at the level of the oviducts of from 70 to 73 centimeters (29 inches).

The weight of the virgin uterus is about 40 grams ($1\frac{1}{4}$ ounces); that of the uterus at term, about 1000 grams (2 pounds), an increase of twenty-five times taking place. The capacity of the uterus at the close of gestation is between 4000 and 5000 cubic centimeters (from 8 to 10 pints), or over five hundred times that of the virgin organ.

The increase in the bulk of the uterus occurring during the earliest months of pregnancy is attributable to the general hypertrophy affecting its walls, and not directly to the developing ovum, since only after the latter completely fills the uterine cavity, at the expiration of the fifth month, is the augmented size of the uterus produced by the mechanical distention caused by the rapidly growing fetus. The enlargement of the uterus, moreover, is not directly dependent upon the presence of the ovum, but is due to actual increase of tissue, as shown by the fact that the hypertrophy of the organ progresses up to the fourth month in extra-uterine pregnancies, the same as if the ovum were present within the uterine cavity.

The hypertrophy of the uterus at first affects equally all parts of the viscus, but later the fundus and the body grow more rapidly than the cervix. The changes which affect the uterine walls consist of thickening of the mucous membrane, increase of the muscular tissue, augmentation of the connective tissue, and enlargement of the blood-vessels, the lymphatics, and the nerves. As a result of these alterations the walls for a time reach a thickness of 1.5 centimeters ($\frac{5}{8}$ inch); but this excessive growth is followed by a marked reduction resulting from the distention incident to the later months of pregnancy, when the extended uterine walls measure but 5 millimeters ($\frac{3}{16}$ inch) in thickness.

The increase of the muscular tunic is effected not only by excessive growth of the already existing involuntary muscle-fibres, which increase from ten to eleven times in length and from three to five times in breadth, but also by the formation of new muscular elements which likewise soon acquire the dimensions of .5 millimeter in length by .02 millimeter in breadth.

The lumina of the uterine blood-vessels are materially increased, the arteries becoming wider and longer—without, however, entirely losing their tortuosity—and the veins dilating into large venous channels, the *sinus uterini*, which penetrate between the muscular fasciculi and which are particularly well developed within the placental area. The walls of the venous canals are intimately united with the surrounding and likewise hypertrophied connective tissue, in consequence of which arrangement the walls of these vessels do not collapse when mutilated, but remain more or less gaping. The lymphatics of the mucosa and the muscular tunic considerably enlarge. The nerves distributed to the uterus also share in the increased growth, especially the *ganglion cervicale*, which more than doubles its usual size.

The form of the uterus undergoes a marked series of changes during pregnancy. During the first three months the pyriform shape is retained; subsequently the organ becomes more expanded in its lower segment, and by the fifth month presents a form intermediate between the spherical and the pyriform, the longest diameter being vertical, and the antero-posterior dimension being greatest just below the middle of the body (Webster). Late in pregnancy the pyriform or egg shape once more predominates, owing to the dome-like distention of the fundus and the broadening of the lower segment.

During the early months all parts of the uterus increase with equal rapidity; after the fifth month, however, the cervix participates but slightly in comparison with the rate of growth manifested in the upper part of the organ. While hypertrophy of the cervix is admitted by all, the extent to which this portion of the uterus contributes to the formation of the excessive uterine sac present at the close of pregnancy is a question regarding which authorities greatly differ. It may be stated at once that the older view, that the cervical canal gradually unfolds itself into the uterine cavity as gestation advances, is no longer tenable, since the investigations of Müller so clearly showed that the cervical canal is but little affected. Regarding the question, however, as to what extent the cervix participates in the production of the uterine sac—whether it retains its integrity throughout the entire canal or contributes a part of its length to the enlarged muscular bag—the solution is less readily at hand.

The differences of opinion concerning these points have arisen more from differences in the interpretation of certain anatomical details than in their variation. It is of interest, therefore, to note the structural peculiarities as repeatedly observed in favorable preparations of the uterus at the close of pregnancy or at the beginning of labor. The classical section secured by Braune of a woman who died during the first stage of labor (Fig. 134) shows,

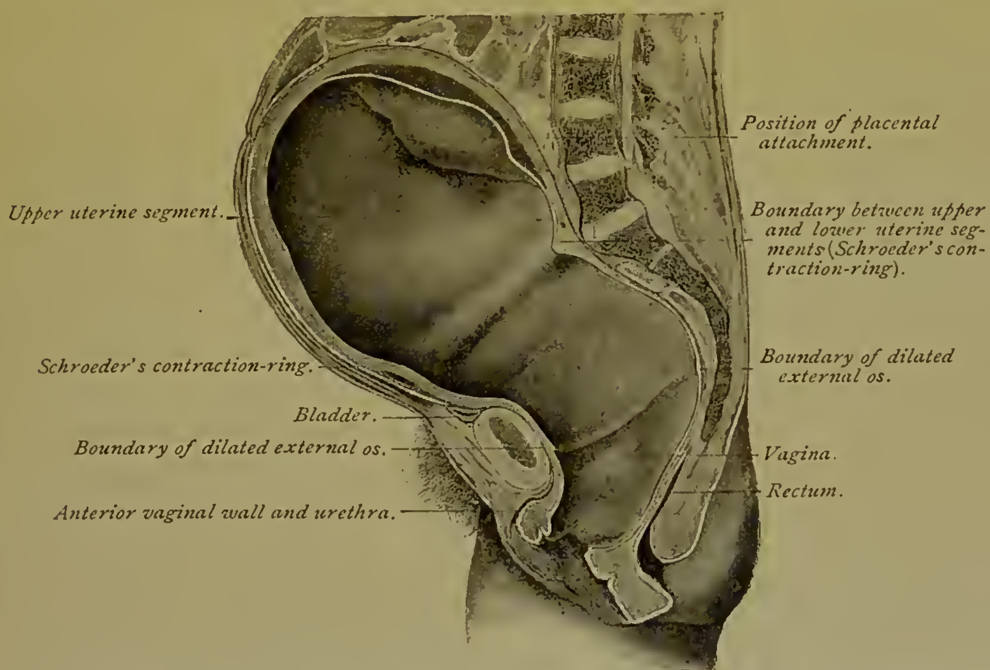


FIG. 134.—Section of the parturient canal at end of the stage of dilatation, from a woman who died during labor (Braune).

in addition to the widely dilated os externum, whose still-defined position indicates the juncture of the uterine and vaginal portions of the parturient canal, two annular markings of much interest. The uppermost of these markings is apparent as a distinct ridge completely encircling the uterine sac and separating the thicker and more voluminous upper segment from the more dependent lower part. This projection was described by Bandl as the dilated true os internum, and as defining, consequently, the upper limit of the cervical canal; by Schroeder the same structure was regarded as a *contraction-ring* which marks the juncture of the upper contracted and the lower dilated *uterine segments*. Some distance lower a second ridge, slightly marked anteriorly, but more conspicuous on the posterior wall, constitutes Müller's ring, which Bandl regards as indicating the upper border of that part of the cervical canal which is unaffected until the dilatation of labor takes place. Schroeder, on the contrary, views this ridge as the true os internum, and the zone included between his contraction-ring above and the one in question below as the inferior segment of the uterus.

From the foregoing it is evident that the significance of the zone included between these two rings is the principal question at issue, some authorities regarding it as a part of the true uterine sac, while others consider it to represent the upper part of the cervical canal, that unfolds before the termination of gestation and thereby contributes to the extension of the uterine sac. According to the first view, the cervical canal retains its integrity throughout pregnancy; according to the second, the canal participates to a limited degree in the formation of the fetal receptacle by dilatation of its upper portion toward the close of gestation. While both views claim distinguished names in their support, the weight of evidence seems to lead to the acceptance of the doctrine attributing a limited participation of the cervix in the formation of the uterine sac of pregnancy.

The cervix of the uterus of the sexually mature virgin is about equal in length to the body of the organ, and only in women who have borne children is the neck relatively shorter (Kussmaul). During the first three months of pregnancy the cervix partakes equally in the general hypertrophy affecting the uterus (see Fig. 137), and reaches a length of 6 centimeters ($2\frac{3}{8}$ inches) or more.

While it is only from the seventh month that the os internum exhibits a tendency to expand into the adjacent uterine cavity, the forces leading to this unfolding begin their influence very much earlier—in fact, as soon as this portion of the uterus has reached its maximum hypertrophy, or from about the fourth month of gestation. In addition to the effects of the presence of the fetus, the traction exerted by the muscular bands—retractor fibres of Bayer—which pass from the outer layers of the uterus into the round and the sacro-uterine ligaments is an important factor in causing the gradual unfolding of the cervical canal. The dilated, funnel-shaped cavity contributed by the cervix for a long time retains its flattened plicæ and is covered by ciliated columnar epithelium; its mucosa finally undergoes conversion into the decidua by changes identical with those taking place in other parts of the uterine mucous membrane. As a result of these changes the cervical canal shortens, and at the close of gestation measures from 3 to 4 centimeters ($1\frac{1}{4}$ to $1\frac{1}{2}$ inches). The unfolding of the cervical canal takes place earlier in primiparæ, owing to the greater resistance of the comparatively rigid muscular tissue of the body of the uterus, until now unaffected by the changes of pregnancy. These changes result in a general softening and elasticity of the body of the uterus from the beginning of gestation, the cervix retaining its usual firmness during the earlier months almost unimpaired. Toward the close of pregnancy the vaginal portion of the cervix projects less and less, the seeming shortening being probably due, in part at least, to the swelling and greater prominence of the surrounding walls of the vagina as well as to traction exerted by ascending and diverging muscle-fibres.

The change of position of the uterus is particularly associated with the rapid growth of the body, but during the early months of gestation this growth results in augmented antero-posterior and lateral diameters rather than in great increase of the longitudinal axis of the organ. In consequence of this increase, together with the increased anteflexion resulting from the additional weight of the hypertrophied tissue, the fundus does not rise above the symphysis until the fourth month. The fundus lies usually to the right of the median line, and often is so turned on its long axis that the left side is directed forward. At the fifth month the uterus fills the hypogastrium, from which time on the rise in the position of the fundus is so regular in its progression that under normal conditions this detail furnishes valuable assistance in the estimation of the stage of pregnancy. During the last two weeks of gestation the uterus sinks within the pelvis, the fundus taking a position somewhat lower than before, resting downward and forward from 7 to 8 centimeters ($2\frac{3}{4}$ to $3\frac{1}{4}$ inches) below the ensiform cartilage. The observations of Webster led this investigator to believe that the sinking of the uterus not infrequently begins long before (sometimes from the fifth month) the last two weeks, the period usually assumed.

The position and relations of the full-term uterus alter with the posture of the woman. In the upright position the fundus bends as far forward as the tension of the distended abdominal walls permits, and rests against the anterior parietes. In the recumbent position the uterus lies against the lumbar part of the vertebral column, the fundus approaching the diaphragm above, with the intestinal coils in front and at the sides. On assuming the lateral posture the large, flaccid uterine sac becomes dependent on the corresponding side.

The relations of the *peritoneum* and the uterus become disturbed in consequence of the altered position of the latter and the excessive tension caused by its enormous proportions. The layers of the broad ligaments become gradually separated and the entire structures shortened, in consequence of which the Fallopian tubes and the ovaries are drawn toward the uterus, against which they lie at the close of gestation.

The changes in the disposition of the pelvic peritoneum during pregnancy have been by no means definitely determined, and opinions differ as to the forces leading to such alterations as well as to the extent of displacement. Regarding the lateral arrangement, it is evident that the increase in the transverse and vertical diameters of the uterus must result in the elevation of the peritoneum on each side of the pelvis to a considerable degree, as conclusively demonstrated by the observations of Barbour and Polk. The arrangement in front and behind, however, is not so clear, and the statements of authorities are conflicting. Polk maintains that the lowest situation of the peritoneum in front and behind the uterus, with the exception of Douglas's pouch, in the non-pregnant condition is indicated by a line passing from the centre of the symphysis to the juncture of the third and fourth sacral vertebræ. At the termination of pregnancy, but before the usual sinking of the uterus within the pelvis has occurred, the lowest limit of the peritoneum, according to the same observer, has ascended and is now marked by a line passing from the centre of the symphysis to the sacral promontory.

These conclusions are not confirmed by examinations of frozen sections made by Webster, since this author finds the inferior limit of the peritoneal pouches during pregnancy as low as in nulliparæ. The changes in the anterior relations of the peritoneum of the vesico-uterine fossa, whereby the peritoneum becomes stripped from the bladder, are usually regarded as due to the elevation of the uterus and to the consequent mechanical effect, which together are also supposed to exert an influence by which the floor of the pouch of Douglas is raised. Webster attributes the stripping of the peritoneum from the bladder, on the contrary, to the drag caused by the gradual sinking of the pelvic floor, since the delicate subserous tissue gives way under the traction, and the peritoneum consequently does not follow the posterior wall of the bladder in its descent. The extent to which the stripping of the serous covering takes place depends largely upon the capacity of the peritoneal folds existing in the non-pregnant condition, as when these are ample less displacement follows than when the traction cannot be met with supplementary tissue. According to Webster, the central portion of the pouch of Douglas at no time during pregnancy becomes elevated; this author further points out that the sinking of the uterus may be progressive from the middle of pregnancy, resulting in the marked downward displacement of the organ sometimes observed before the end of gestation.

The vagina also exhibits changes resulting from the exaggerated nutrition of pregnancy. These changes include greatly increased vascularity, thickening and softening of its mucous membrane, whose folds become less rigid and conspicuous, and hypertrophy of the muscular tunic with great dilatation of the blood-vessels. In consequence of the large quantity of blood contained within the less compact tissues, the vaginal surface presents a bluish tint in contrast with the bright red of its usual condition. This change of color is regarded by some as a valuable objective sign of pregnancy.

The external genitals likewise participate in the increased hyperemia of the generative tract, the unusual development of the blood-vessels and the lymphatics inducing a condition characterized by softening and greater infiltration of the tissues, hence the vulva appears particularly prominent. The excessive vascularity of the parts finds expression in the dusky hue and the unusual activity of the sebaceous follicles and the sweat-glands of the labia.

The articulations of the pelvis exhibit to a limited degree changes due to pregnancy. These changes are manifested by an unusual softening and vascularity of the interarticular cartilage, particularly that of the symphysis, in consequence of which there takes place a certain amount of loosening, attended in some cases with slight movement. Whatever temporary increase in the pelvic boundary may thus be secured, the gain at best is probably very insignificant.

Other changes affecting the *pelvic floor* and the parts closely connected therewith, such as the base of the bladder and the urethral orifice, result from the downward displacement of the structures closing in the outlet of the pelvis. The pelvic-floor projection is progressively increased from 2.5 centimeters (1 inch) in the nullipara to 9.5 centimeters ($3\frac{3}{4}$ inches) at the end of pregnancy; the skin-distance from the symphysis to the coccyx is almost doubled.

The following table, compiled by Webster, based on the observations of himself and of other observers, displays some of the more important variations induced by pregnancy within the parts in relation to the pelvis:

	Nullipara.	Fifth Month.	Eighth Month.	Ninth Month.
	Cm.	Cm.	Cm.	Cm.
Pelvic-floor projection	2.5	4.1	5.0	9.5
Skin-distance from coccyx to symphysis	13.5	14.0	16.5	25.5
Distance of urethral orifice below brim	6.1	6.7	6.7	9.5
Distance of urethral orifice below symphysis	0.6	2.5	3.2	3.2
Distance of junction of bladder and urethra below brim	6.4	7.6	6.3	7.0
Thickness of tissue between pubes and vagina	1.6	2.8	3.5	4.4
Depth of utero-vesical pouch below brim	5.7	5.5	6.7	6.0
Distance of os externum below brim posteriorly	6.3	11.1	8.7	8.9
Distance of os externum below brim anteriorly	6.3	11.1	8.7	9.2
Distance of os internum below brim posteriorly	5.7	7.9	7.0	6.0
Distance of os internum below brim anteriorly	5.7	7.9	7.0	6.7

The abdominal walls manifest the enormous distention to which they are subjected by the formation of more or less conspicuous lines—the *striæ gravidarum*—which are found in over 90 per cent. of pregnant women. These lines appear as reddish or bluish, sometimes lighter, streaks, which are most numerous and well marked during the last months of pregnancy over the lower part of the abdomen, particularly at the sides. They extend as curved or sinuous lines, and they persist for some considerable time after the termination of gestation, gradually becoming whiter and more cicatricial in appearance. These striæ are due to displacements and partial rupture and atrophy of the connective tissue of the deep layer of the greatly distended cutis. They are not peculiar to pregnancy, but may appear even in men whenever the skin is subjected to unusual stretching, as from tumors, ascites, and other causes; furthermore, they are not limited to the abdomen, but in pregnancy are seen on the nates, the thighs, and the breasts.

The linea alba also not infrequently becomes broader, and in multiparæ the recti muscles are sometimes so widely separated that the mass of the uterus appears between as a median projection.

The umbilicus is affected by the increasing bulk of the abdominal contents, and by the fifth month begins to exhibit a diminution in its depths; by the seventh month its depression has become obliterated, and during the remaining weeks it becomes gradually everted until the umbilicus forms a rounded elevation.

The mammary glands, coincidently with the changes affecting the generative organs, undergo important alterations during the preparation for their assumption of the stage of functional activity. These changes early induce greater general volume in the breasts, depending upon an increase both of the interlobular connective tissue and fat and of the true secreting tissue of the glands. The enlargement of the breasts begins as early as the second month, but it does not become conspicuous until toward the middle of preg-

FIG. 135.—Virgin nipple and areola: 1, nipple; 2, areola; 3, tubercles of Morgagni; 4, crevice at base of nipple.

nancy. On touch the periphery of the organ presents uneven and knotty masses consisting of the enlarged acini and lobules of the rapid-growing glandular tissue imbedded within the areolar and adipose tissue. The ultimate compartments of the secreting structure become earliest enlarged; conse-

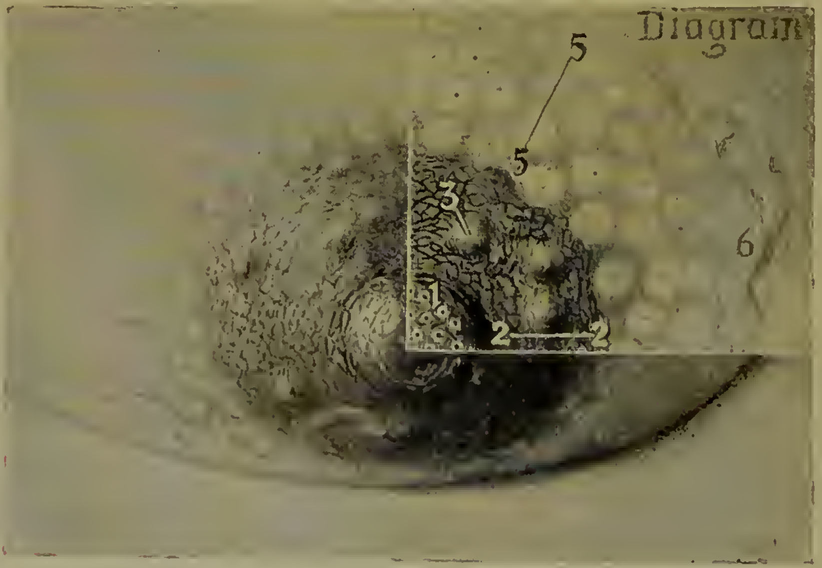


FIG. 136.—Nipple and breast of pregnancy: 1, nipple with openings of milk-ducts; 2, primary areola; 3, glands of Montgomery; 5, secondary areola; 6, venous circle of Haller.

quently the increase is first noticeable at the periphery, afterward extending along the course of the larger ducts toward the centre of the organ. The distention of the skin due to the augmented volume of the glands is especially marked over the periphery, in which location reddish, bluish, or whitish striæ, similar to those seen upon the distended abdominal walls, appear as manifestations of the unusual tension of the integument. The veins are also enlarged, and show through the tightly drawn skin as a network of blue lines.

The nipple shares in the general hypertrophy of the organ, becoming enlarged, more readily erectile, and sensitive. The surrounding rosy areola of the virgin (Fig. 135) is gradually replaced by a more deeply colored area, whose tint by the middle of pregnancy varies from the slight brownish discoloration seen in women of light complexion to the dark brown or almost black color seen in brunettes (see Pl. 17). The areola by the eighth or the ninth week becomes softer and more elevated than usual, and its sebaceous glands, from one to two dozen in number, greatly enlarge, those at the periphery becoming particularly conspicuous. These enlarged sebaceous follicles constitute the glands of Montgomery (Fig. 136). The mammary areola varies from 2.5 to 4 centimeters (1 to $1\frac{1}{2}$ inches) in diameter, although these dimensions may greatly be exceeded. In the fifth or the sixth month of pregnancy an additional irregularly pigmented area, the so-called "secondary areola," sometimes appears (see Pl. 17).

After the third month of gestation the breasts contain a thin fluid, the colostrum, which may be pressed out of the newly formed glandular tissue. This fluid consists of a thin albuminous medium containing numbers of fat-drops, displaced epithelial cells, and characteristic aggregations known as "colostrum-corpuscles."

2. **General Changes.**—Pregnancy, while a purely physiological condition, creates great and important changes in the maternal organism. These changes pertain to the different systems and organs of the body; to some more than to others. The general changes in the maternal organism depend to a great extent on the alterations in the blood and in the functional modifications of the nervous system. The pregnant woman has to provide nutriment, to breathe, to maintain blood-circulation, to secrete and to excrete for two individuals—herself and her fetus. All this means that extensive changes in the general system must occur. If these changes are carried to a reasonable extent, health is maintained and the system becomes fortified, as it were, for the coming parturition; but when these changes are developed to excess, disorders complicating the pregnancy are produced.

Changes in the Circulatory System.—Formerly it was supposed that pregnancy was accompanied by blood-changes like unto plethora, and it was almost universally inferred that the attending symptoms—the headache, the ringing in the ears, the flushed face, the cardiac palpitation, and the dyspnea—were the results of these alterations. Consequently it was a very common practice with physicians many years ago to bleed pregnant women from one to many times at intervals during the latter months of pregnancy. Enormous quantities of blood were thus extracted by venesection. A wonderful revolution has taken place in the treatment of pregnant women during the past twenty-five years, owing to more rational ideas of the real condition of the circulatory fluid.

In pregnancy the composition of the blood, which is increased in quantity, is profoundly altered, as many careful analyses prove. The quantity of blood present before pregnancy would be inadequate to meet the condition of pregnancy. Thus, the blood is increased in its watery elements and white corpuscles, but is made deficient in the element of albumin, is increased materially in the amount of fibrin, and is diminished in the proportion of red corpuscles—conditions of anemia, hydremia, and hyperinosis. This hyperinosis is also augmented after parturition, because at this time large quantities of effete materials are thrown into the circulation.

Instead of a blood-change called "plethora" being present, it should be recognized as one of anemia and hydremia or of chlorosis. If called "plethora," it should be named *serous* plethora. Individual variations in the quantity and quality of the blood are dependent on many conditions of hygiene and diet; poor hygiene reduces the blood to marked chlorosis and hydremia. The surrender of the maternal nutritive material to a growing fetus and a developing uterus, to pelvic tissue, and to glands means a great tissue-drain on the maternal circulatory fluid. As these changes in blood-quality are most marked at the close of utero-gestation, the attending phenomena must be those that are most strongly shown. Certain thrombotic affections observed in pregnancy and after delivery are thus explainable. In place of the blood-supply at this time being improved by bloodletting, it must clearly be evident that venesection is strongly contra-indicated, for it tends further to aggravate the abnormal alteration. To Cazeaux are we indebted for much of our present knowledge of the blood-changes of pregnancy.

Certain viscera of the circulatory apparatus are also much modified in size and in function. The heart becomes physiologically hypertrophied—a fact known for many years and determined by numerous observations. This hypertrophy is a wise provision of nature to meet the increasing exigencies of the blood-supply in the advancing months of pregnancy. Hypertrophy of the heart is constantly present to a considerable degree, the whole weight of this organ being one-fifth more in the pregnant than in the non-pregnant state. The left ventricle, the propelling part of this organ, is alone affected. This physiological hypertrophy remains during the period of lactation in those who suckle their children, otherwise the organ quickly diminishes in size; hence in women who have borne many children the heart may remain permanently large. Incident to the total blood-supply in pregnant women the maintenance of the circulation demands either greater frequency in the heart-contractions or an increase in the entire quantity of blood entering the left ventricle. The multiplied vascular elements of the pelvic organs also increase the labor thrown on the heart.

Disturbances of the circulatory organs are very often seen. Thus, palpitation, while purely sympathetic in the earlier months of gestation, later come on from the encroachment of the enlarged and enlarging uterus pushing up the diaphragm and embarrassing the heart's action. The blood-changes of anemia and of hydremia may be so great that edema may be observed in the feet and may extend upward to the thighs and the labia majora.

Other organs are likewise increased in size. The liver and the spleen are enlarged. The spleen normally increases in size, owing to an important relation to the quantitative change in the circulatory fluid. A fatty degeneration shows itself in both the liver and the spleen in women who have suddenly died after labor. Numerous small yellow spots are seen scattered through the liver—fatty deposits in the hepatic cells. The thyroid gland is increased in size. In women in whom there is a predisposition to this enlargement, pregnancy may further stimulate the growth and bring about permanent structural changes. The enlargement, of this organ is thought to sustain some relation to changes in the heart and the blood-glandular system.

Changes in Respiration.—Pressure of the enlarging uterus, through mechanical action, causes changes in the respiratory organs. An upward movement of the diaphragm lessens the longitudinal dimensions of the thorax. Some embarrassment of the respiration follows this decrease, notwithstanding that there is some increase in the breadth of the lower thorax. In the last two weeks of utero-gestation, owing to the limited shortening of the cervix uteri and to the settling down of the fetus *in utero*, respiration and circulation become easier.

As more blood must naturally be provided to nourish the woman and her child during pregnancy, this extra blood must not only be properly circulated, but must also be duly purified. The elimination of carbonic-acid gas by respiration is therefore increased in pregnancy.

The respiratory organs may be deranged by cough and dyspnea originating from nervous sympathy in the earlier months of pregnancy. In the later months of gestation the derangement is from encroachment of the gravid uterus, interfering with normal respiration. These phenomena are mostly observed when there is twin pregnancy or dropsy of the amnion.

Changes in the Digestive System and in Nutrition.—The pregnant woman provides the nutritive pabulum by which the growing organs are sustained and by which the fetus and its appendages are built up. She must therefore digest more food, form more blood, and increase the activity of the secretory and excretory organs. Very few women escape such troubles of digestion as nausea and vomiting. In the earlier months the appetite is, as a rule, capricious. Further along the appetite and the digestion increase in activity, thereby assisting in improving the general nutrition.

An increase of weight takes place in normal cases, irrespective of the growing uterus and the ovum. The average gain amounts to from ten to fifteen pounds in the whole nine months, being greatest in the last two months. This increase is not far from one-thirteenth of the whole body-weight, and it is progressive from the beginning to the end of pregnancy, notwithstanding the nausea and vomiting.

The adipose tissue increases most in bulk, especially in the latter half of gestation. These deposits are most noticeable in the mammary glands, in the abdominal parietes, in the hips, and in the omentum. The whole figure becomes fuller and rounder. All this increase is but so much stored-up potential energy, to be utilized after delivery, when this energy, by the metabolism of the body, assists the mammary function.

Rokitansky has spoken of the lamellæ of osseous material on the inner surface of the skull and the frontal and parietal bones external to the dura mater, called "puerperal osteophytes." These lamellæ, which are irregular in shape, consist of calcium carbonate, traces of phosphates, and organic matter. They are not peculiar to pregnancy. Robert Barnes thought they sustained some relation to the calcareous changes found in the placenta and to the forthcoming milk. The temperature of the body in pregnancy is not materially changed, although, according to some authorities, it is slightly lower in the morning than during the day.

Changes in the Skin, the Gait, and the Osseous Elements.—The functional activity of the sebaceous glands, the sweat-glands, and the hair-follicles of the skin is increased by pregnancy. It has been said by Robert Barnes that the growth of the hair is invigorated during pregnancy when prior to gestation the hair had been falling out.

Pigmentations are quite generally observed in spots over the body, the lineæ albicantes being most noticeable. They are also seen about the abdomen, the navel, and on the face. Around the nipples these deposits may be seen in the form of areolæ, primary and secondary (see Pl. 17). These pigmentations vary much in extent and in intensity in different subjects, being more marked in brunettes than in blondes. Seldom do these deposits completely disappear, but they are always less after parturition. It is not unlikely that they are the result of a temporary hypertrophy of the suprarenal capsules.

There is also a change in the gait of a pregnant woman. To preserve the centre of gravity of the body the head and shoulders must be thrown backward. This action produces a change in the gait most noticeable in women of low stature.

Owing to the drain on the osseous elements of the blood during pregnancy by the growing fetus, there is always a considerable delay in the union of fractured bones.

Changes in the Urine.—Owing to the hydremic condition existing during pregnancy, the urine becomes more abundant and of a lower specific gravity. It is thought that the kidneys become enlarged, which is probably the case. This change in the size of the kidneys has somewhat to do with the increased quantity of urine, but more probably the more active function is attributable to the increased blood-supply and to the increased arterial tension.

There are also qualitative changes in the urine. The chlorids have been found increased, while the phosphates and sulphates are decreased, due to their use in the growth of the fetus. The kiestein pellicle found upon the urine of pregnant women several hours after its excretion has no necessary relation to pregnancy, because it is found on the urine of virgins and on that of men.

The glucose found in the urine of many pregnant women in variable quantities has been referred to a pathological increase in the glycogenic function of the liver. Sugar is present in the urine of almost every woman at some period of lactation being influenced much by the character of the diet. Its presence depends on the quantity and quality of the milk, diminishing as the lacteal secretion is suppressed.

Traces, more or less in quantity, of albumin are found in the urine. Authorities differ as to the frequency of albuminuria in pregnancy. Schroeder says that the urine of all pregnant women will contain albumin in from 3 to 5 per cent.; other authors have contended for a much larger percentage (from 20 to 30). Unquestionably, albumin is found in the urine of a very large number of pregnant women. No regard being paid to the number of pregnancies, nor to the previous condition of the kidneys, the presence at some time of a trace of albumin will be found in a very large number of cases. The writer, who instituted these examinations in a large clinical experience in hospitals, has found the frequency to be at least 30 per cent. This frequency must be inquired into with reference to its etiology. In the first place, quite a number of pregnant women have a physiological albuminuria. The trace of albumin is then small and of short duration; there are no tube-casts, and no attending morbid symptoms. Every authority must coincide with Möricke, that albuminuria is relatively commoner during labor than during pregnancy. A prolonged labor is oftener thus accompanied than is a short and easy labor. Albuminuria is often confined exclusively to the period of labor. The occurrence of albuminuria during labor is explained by the theory that the reflex vaso-motor spasm of the renal arteries, resulting from uterine contractions, causes renal anemia. This theory has the support of Tyler Smith, Spiegelberg, and others.

Renal albuminuria may appear early in pregnancy, before there is any possible renal venous stagnation from pressure, being the result purely of reflex irritation. Why should not this irritation at times be transferred from the uterus to the kidneys as well as to the stomach? Such an explanation must hold good, if albuminuria is present early in pregnancy, the urine having been normal before that time. There is an intimate connection between the nervous ganglia of the pelvis and the nerve-filaments of the kidneys.

The hydremic state of the blood incident to pregnancy is at times a cause of albuminuria. An increased arterial tension which exists in pregnancy may be productive of albuminuria. The urine of a pregnant woman may be albuminous from causes not nephritic, yet morbid. Thus, it may be albuminous from blood, from mucus, or from pus in the urine, each of which may be cystic, vaginal, or uterine in origin.

The prevalence of albuminuria during pregnancy may be classified as follows: (*a*) Cases in which it was present when conception took place, a chronic Bright's disease of some type, with albuminuria, having existed before pregnancy; (*b*) Cases in which albuminuria from sub-acute or chronic Bright's disease, the result of scarlet fever, etc., had existed years before, and from which disease a recovery seemingly had taken place: at least there was no trace of albumin in the urine at the time of conception; (c) Cases in which the existing pregnancy or parturition was attended by an albuminuria, it having never existed before.

In the first two divisions of the above classification pregnancy aggravated or caused a return of the albumin. In the last division albuminuria started during, and had been clearly attributable to, the condition of pregnancy.

Excepting, then, the cases in which the albuminuria has been due to physiological or pathological causes, not nephritic, and not attributable to pregnancy, the author is disposed to think that the estimate made by Schroeder (3–5 per cent.) is not wide of the actual facts.

The oldest theory is that albuminuria and kidney disease during pregnancy are due to mechanical pressure of the gravid uterus on the renal blood-vessels, especially on the veins. All admit that this mechanical pressure predisposes to, if it does not excite, the disease. This doctrine has been ably advocated by Simpson, Carl Brown, and Cazeaux. It is not so much the renal pressure alone as it is the intra-abdominal pressure that so acts. Support of this theory is obtained from the following facts:

Albuminuria is more common in the latter half than in the first half of pregnancy. More cases exist among primiparæ, in whom there is great abdominal pressure from the rigid, unyielding abdominal walls. Albuminuria is greater in twin pregnancy; it is also common when there is a severe pressure from large uterine fibroids or from ovarian cysts. Tight lacing and heavy skirts aggravate the disease. It is less frequent during gestation than during labor, when pressure is greatest; it diminishes after labor or after the removal of the abdominal tumors. Any cause that brings about renal venous stasis predisposes to and excites nephritis. For instance, valvular defects and pulmonary emphysema, as well as pregnancy, may develop true parenchymatous inflammation of the kidneys.

No one of all the above theories or facts constitutes a sufficient explanation for all cases. Each fact or theory may answer for some cases; two or more combined afford a better solution for most. All can recognize the influence of intra-abdominal tension with pressure on the vena cava and its branches, especially in primiparous women. The sinking of the fetal head into the true pelvis in the last two weeks of pregnancy, while it improves the respiration and circulation in general, does not relieve the renal venous stasis. While most women feel lighter and freer during these last two weeks, owing to the settling down of the fetus from the shortening of the cervix, the intra-abdominal and pelvic pressure is not diminished.

So great is the significance of albuminuria during pregnancy that its presence should always be watched for. Frequent physical, chemical, and microscopical examinations of the urine should be made in the latter months of pregnancy. If the presence of albumin is but slight, it may be physiological, or, if pathological, no noticeable symptoms may be observed; but if it is considerable and persistent, and if it occurs early in pregnancy, the prognosis is grave. Albuminuria is then a condition full of ill omen, although it is always susceptible of amelioration by well-directed treatment, and in many cases it may entirely be overcome.

From a clinical standpoint it is ordinarily presumed that when there is albuminuria there is also uremia to a corresponding degree. Doubtless it is true that when albumin is abnormally excreted by the kidneys there is some retention of urea in the blood, from defective action of the kidneys, but certainly these two functional disorders do not hold the same proportion or relation. There may be much albuminuria and but little uremia, and *vice versâ.* It is the degree of the latter disorder that forebodes evil. The whole line of treatment should be directed toward favoring the elimination from the blood of this poisonous material of urea, with its products. To secure this result it is incumbent upon us to act as potently as we can upon the bowels and the skin—compensatory organs of the kidneys—and to address our remaining treatment to controlling other symptoms that may arise.

Changes in the Nervous System.—The nervous system becomes more impressionable in pregnancy. The emotional susceptibility is markedly increased and the whole character is altered. A woman may become fretful, peevish, irritable, and at times unreasonable. The most amiable woman may thus be disposed when pregnant. She is often depressed in spirits at first, when her general nutrition is impaired from an imperfect appetite or a faulty digestion. Mania may be excited later on—easily in those who are thus predisposed by inheritance or by actual melancholia. These conditions are among the most troublesome of the various complications of pregnancy. To witness a woman in the process of child-bearing impaired in her mental functions is indeed sad. There are cases, however, in which a sense of well-being takes the place of one of more or less physical debility. A condition of want of mental and physical activity before pregnancy at times becomes changed to one of buoyancy and exhilaration. Physically such women are stronger, and mentally they are more active and energetic. No factor enters so much into the causation of this mental cheer and despondency as the psychical—the degree of the desire for an offspring.

II. DIAGNOSIS OF PREGNANCY.

1. Symptoms and Signs of Pregnancy.

1. **The Nausea and Vomiting of Pregnancy, called the "Morning Sickness."**—This symptom consists of nausea, accompanied often with vomiting or the retching of a glairy fluid, showing itself early in the morning, generally before, at times only after, breakfast. The assumption of the erect posture seemingly excites the disorder. Sometimes it begins very early, within a few days after conception, but usually not until the fourth or the fifth week of pregnancy. Seldom does it persist throughout pregnancy, but generally ceases spontaneously within the fourth month, although it may continue

throughout the whole period. In many or in most cases it is comparatively mild, and does not seriously impair the health, its presence being regarded as a favorable omen; but as there is every degree of seriousness in its nature, it is at times so severe and so long continued that not only are parts of meals vomited, but all foods, of whatever kind, variety, or quantity, are also rejected. Not only may the ingestion of food excite vomiting, but the sight or the smell of food may also give rise to this characteristic nausea.

Morning sickness is a sympathetic disorder reflected from the uterus. It is aggravated by unpalatable food, by sexual excitement, and by emotional disturbances. It is most marked in first pregnancies, and in women of highly nervous organization—a fact ever to be considered in the management of this affection. It is a suspicious or presumptive evidence taken by itself, but when associated with certain other symptoms and signs it becomes a more probable symptom of pregnancy. Not necessarily in the regular order of time, but quite generally associated with this morning sickness, there are certain morbid longings for food; for instance, foods and drink and certain vegetable acids formerly disliked are now desired; the most unpalatable substances, such as chalk, clay, and slate-pencils, may be craved; or there may be a distaste for the usual articles of diet. Other stomach disorders, such as acidity, flatulency, heartburn, and unpleasant eructations, are sometimes noticed.

Salivation is a very common accompaniment of the morning sickness when the latter is severe. A constant dribbling of the saliva by day or by night occurs in the earlier months of pregnancy, and its severity and duration remain for an uncertain period. It has been observed to continue for months after the abatement of the nausea and vomiting.

Toothache.—Under the above heading may also be included toothache, which at times is a purely functional disorder; more often it is a symptom of actual caries, arising from alteration of the buccal secretion, dissolving the lime-salts of the enamel of the teeth; or it may be the result of a morbid determination of the ossific elements of the teeth of the mother to the bones of the growing fetus.

2. **Menstrual Suppression.**—The second symptom more or less expressive of the existence of pregnancy is the suppression of the menses. The function of menstruation is almost always suspended throughout the whole period of pregnancy. So reliable is this symptom that the determination of the end of gestation, or the time for the expected parturition, is best obtained by adding from two hundred and seventy-eight to two hundred and eighty days to the date of appearance of the last menstrual flow. But not invariably is menstruation suspended following an impregnation. The most frequent exception to the general rule is found when menstruation returns once only; then it is usually for a somewhat shorter time and in diminished quantity. The occurrence of a menstrual flow in diminished quantity and for a shorter time in a married woman who has had her menstrual periods regular as to time, quantity, and duration is very significant of a possible pregnancy, and the conception must have occurred several days before this function last appeared.

Again, by way of exception to the rule, there are recorded notable instances in which the period of pregnancy was attended by a regular menstruation. The writer recalls in his experience the case of a woman, now living and in health, who never menstruated before marriage, nor during her married life of several years unless she became pregnant. She had no menstruation the first two years of her married life until pregnant, and there was no return of the menstrual flow until she was again pregnant; in other words, menstruation in this case was never present except during pregnancy, when it was normal in all regards, having thus appeared in three distinct pregnancies. Possibly the periodic hemorrhage in this case was of cervical origin, but no pathological lesion of the uterus could be detected. Menstruation occurring during the first three months of pregnancy may come from the decidual cavity of the uterus, not yet closed, before the decidua vera and the decidua reflexa have become agglutinated; then there must have been a certain amount of chronic decidual endometritis—a morbid state, of course.

As many causes purely pathological—general and local, physical and psychical—induce menstrual suppression, the exact significance or the relative value of this symptom, as an evidence of the existence of pregnancy deserves most careful consideration. For instance, menstrual suppression following months and years of menstruation, normal in all regards, is a very strong suspicion of pregnancy. Its value as evidence becomes less when it is stopped in a woman whose previous periods have been irregular from any cause. This symptom of menstrual suppression cannot, of course, be present from pregnancy when the menses are physiologically absent from lactation, or when the pregnancy occurs before the first menstrual appearance, prior to puberty or after the menopause. So much faith has the popular mind in the presence of this symptom of menstrual suppression as indicative of pregnancy that no small degree of anxiety in looking forward to a pregnancy is often manifested by women. There is what is called "psychical amenorrhea," in which case menstruation is suspended or is delayed from purely psychical causes. While it affects newly-married women who may be anxious to avoid pregnancy, it concerns mostly unmarried women who have exposed themselves to the possibility of impregnation. The fear of a possible pregnancy is doubtless sufficient to prevent a normal return of this function.

All the exceptions above mentioned should ever be held in mind in estimating the actual worth of the symptom of menstrual suppression.

3. **Mammary Changes.**—During pregnancy the mammary glands are in immediate sympathy with the growing reproductive organs of the pelvis, consequently a genuine physiological hypertrophy commences in these organs from the beginning of gestation. Their glandular structures become larger, fuller, and firmer; a sensation of weight or of pricking in them is felt by the patient; the veins, blue in color, become enlarged and more visible. Light-colored, silvery lines are seen radiating over the projecting organs in the last months of pregnancy. The nipples also become enlarged, more elongated, prominent, and somewhat erect (Pls. 17, 18). Surrounding the nipple is noticed the

areola, which becomes darker in color, and which is most pronounced in brunettes (Pl. 17). Two or more enlarged moist follicles, varying in size and containing sebaceous material, are seen projecting from the surface of the areola. In the fifth or the sixth month there appears a secondary areola (Pls. 17, 18) consisting of scattered round spots, appearing as if the color had been discharged as a shower of drops (Montgomery). Thus every structure entering into the composition of the mammary glands is physiologically hypertrophied. These changes begin as early as the second month, and become more pronounced as pregnancy proceeds. The two mammary glands are equally enlarged and progressively developed. The secretion of colostrum in the glands enhances the value of these mammary changes indicative of pregnancy, especially if noticed in women who have never before been pregnant. Milk is now and then seen to ooze from the nipples of some women before delivery (Pl. 17); in most women a drop or more of colostrum may be squeezed from the nipples after the third month. Instead of the lacteal secretion being promoted, its suppression in nursing women is very suspicious of another pregnancy. Milk is secreted at times, though rarely, when there is no pregnancy. Pelvic diseases, such as chronic metritis, rapid-growing fibroids, ovarian cystomata, and false pregnancy, at times induce milk-secretion. Cases are recorded of the presence of milk in the mammary glands of males. These characteristic physiological changes, in their uniformity and progressiveness, mark the distinguishing differences between the mammary changes of pregnancy and those alterations noticed in size and shape of the glands from sympathy with certain pelvic diseases—ovarian and uterine.

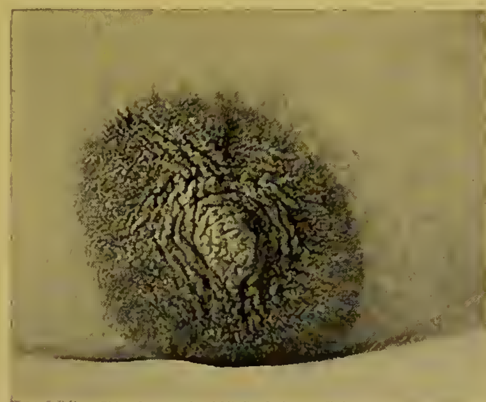
These mammary changes in structure, color, and function are of little diagnostic value when considered alone, but when taken in conjunction with other symptoms they are highly probable evidences, especially in first pregnancies. Owing to the fact that the darkening of the areola in multiparæ, and the erectility of the nipple remain more or less prominent, while colostrum may sometimes be present for years after the cessation of lactation, it can be appreciated how these signs lose their diagnostic value in women who have borne children.

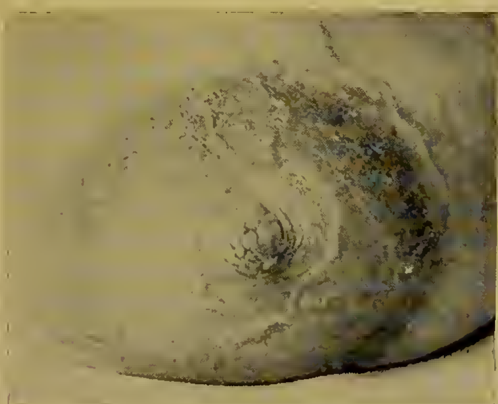
4. **Functional Disturbances of the Bladder.**—Functional disturbances of the bladder are quite often noticeable early in pregnancy. As the bladder is somewhat dragged upon by the physiological prolapsus of the uterus in the first month (a position rather increased in the second month), and as it is pressed upon during the third month by the increasing normal anteversion, it can be understood why functional disorders of this organ may result. The bladder-capacity is diminished, and in consequence there is an increased frequency of urination. The vesical symptoms tend to diminish in the fourth month, because of the ascent of the uterus from the pelvic to the abdominal cavity. If retroversion of the uterus existed prior to pregnancy, this backward mal-position is increased, while the uterus is pelvic in position. Because of the increasing size of the organ, with its growing contents, there follows, at times, from retroversion, serious urinary retention. Incontinence of urine more

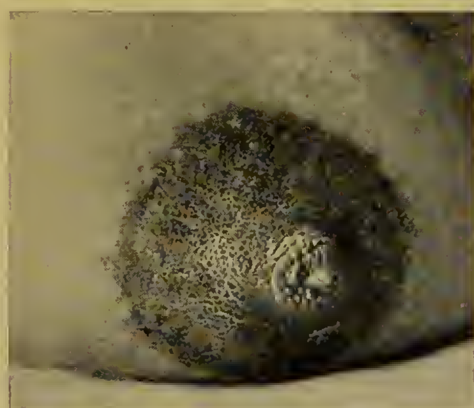
Primary areola, elevated and edematous (PA), with follicles (in a blonde).

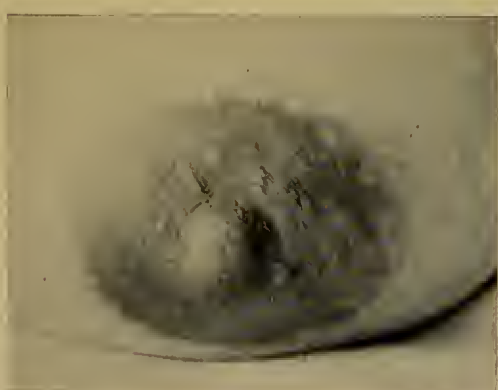
Primary areola, pigmented (PA), but flat, with small nipple (in a brunette).

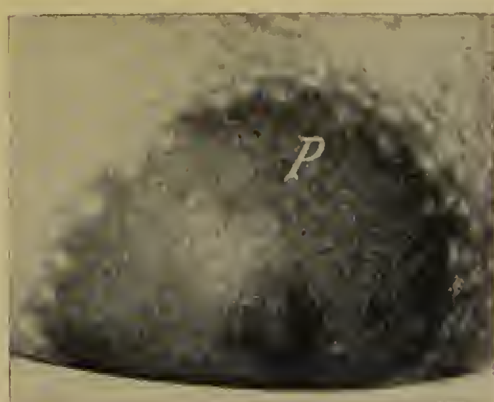
Montgomery's follicles (F), largely developed.


Erectility of nipple and primary areola.


Veins coursing over the breast and primary areola, with irregular pigmentation (in a blonde).


Milk, with faint secondary areola (in a brunette).


Secondary areola of usual size (in a brunette).



Secondary areola, prominently marked (S), with wide primary (P) areola (in a brunette).

Mammary signs of pregnancy in their order (two-thirds life size).

Elevation of primary areola (E) in profile, compared with an areola which is not elevated (composite photograph).

Well-formed, firm breast and nipple (in a brunette).

Typical signs in a brunette, including follicles and primary and secondary areolæ.

Typical signs in the blonde: F, follicles; PA, primary areola.

Mammary signs of pregnancy.

vix takes place, when the cervical canal is merged into the upper uterine cavity—a result, no doubt, of the incipient uterine contractions preparatory to labor, as pointed out by Matthews Duncan.

The broadening of the cervix in the last stage of pregnancy, prior to eight and one-half months, then, is, seemingly, not real until the last fortnight. More or less of these changes remain even after parturition; in other words, the cervix does not completely resume its pristine virgin firmness and smoothness of surface or its original size.

While these changes are noticeable from pathological as well as from physiological causes, their value in the diagnosis of pregnancy is only to be relied upon, when associated with other signs and when taken in conjunction with certain other symptoms.

(*b*) *The Violet Color of the Vulvar and Vaginal Mucous Membrane.*—Dr. Jacquemin of Paris first discovered this sign, and Dr. Chadwick of Boston has fully dwelt upon its diagnostic significance. Inspection reveals its presence. It is of importance in the earlier months of pregnancy, when there is seen the then pale violet color, becoming more bluish as pregnancy advances. But this sign is not of positive value. While arising from a venous stagnation in the vaginal vessels, it may come also from vaginal or uterine congestion due to disease. This sign is valuable often as early as the second month, and in the latter half of pregnancy it is highly diagnostic; then its recognition possesses great value.

(*c*) *Hegar's sign*, which has been given to the profession within the last decade, possesses a great advantage. In all doubtful conditions of early pregnancy this sign ought to be searched for. It is to be detected by vaginal touch and by bimanual examination. Its presence implies a change in the consistency of the lower uterine segment. The greatest changes in the uterus must and do take place in the body of this organ—the bed, as it were, for the growing ovum. The neck of the womb is less supplied with blood, and it receives comparatively little of the stimulus of pregnancy. The development of the cervix is largely completed by the fourth month. During the first six or eight weeks of gestation the body of the uterus enlarges, especially in its antero-posterior diameter. Bimanual, recto-vaginal, or abdomino-vaginal touch will detect some enlargement in all directions—anterior, posterior, and lateral. The lower uterine segment becomes soft, compressible, and pulsating; above there is the projecting or bulging uterine wall, hard and

FIG. 138.—Pregnant uterus of early part of third month (Braun's frozen section), with probable post-mortem retroversion: D, D, decidua vera.

resisting during uterine contraction, boggy or soft during relaxation. The accompanying illustrations (Figs. 138–140) best elucidate these facts. The uterus in shape has been likened to that of a demijohn, to an old-fashioned fat-bellied jug, or to a sphere (corpus) resting upon a cylinder (cervix). These alterations in consistency, while noticed on the posterior wall by rectal touch, are best detected along the anterior uterine wall, by the finger in the vagina with

FIG. 139.—Bimanual signs of the sixth to eighth week, showing diagrammatically the alterations in consistency of cervix and corpus uteri: A represents the vaulting or overhanging of the body and its elastic feel, with the compressibility of the lower uterine segment and the unyielding cervix; B shows the conditions during uterine contraction, when the body is hard and globular.

the outer hand on the abdomen seizing the uterus. The structures of the corporeal wall may become soft and yielding, and may show a contrast with the cervix below. It is true that the sign of *bogginess* of the body is not always present, and that its presence is simulated somewhat by morbid states, but the peculiar compressibility of the lower segment, together with the bogginess of the body and the changes in shape of the womb, is not simulated by anything else.

(*d*) *Changed Position of the Uterus.*—We must not fail to bear in mind the modification in the positions of the uterus that pregnancy usually produces.

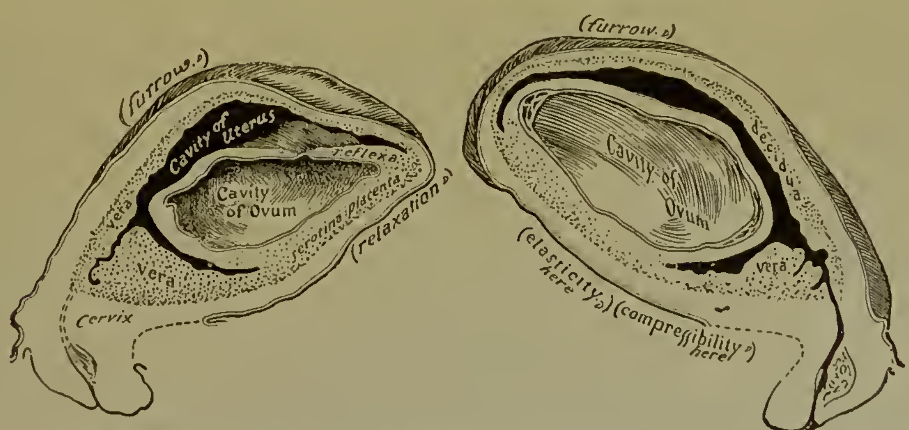


FIG. 140.—Frozen section of uterus at two and a half months (Pinard), showing relaxed and thin walls, thickened decidua; with the clinical findings of Figure 139 it will be seen how the bimanual signs originated.

In the first and second months the uterus is somewhat lower, but in the third month it undergoes an increased anteversion, for the reason that the relatively increasing weight of the body of the uterus with its growing contents tilts the upper end of the uterine lever downward and forward. This change in position will be noticed in all cases except those in which pregnancy has occurred in a previously retroverted uterus; the retroversion is then increased.

This statement is made, notwithstanding that some of this anteversion may be apparent, not real, the antero-posterior diameter of the organ being thickened.

Hegar's sign, recognized, as it may be, so early as the second month, and the overhanging and softness of the corpus, the changed position of the uterus, and the violet color of the vagina and cervix uteri, while not absolutely positive signs, are highly probable evidences when associated with some of the rational symptoms referred to. They possess a diagnostic significance ever to be watched for and carefully estimated. They are a complexus of physical signs that gives a reasonable diagnostic certainty.

6. **Abdominal Changes.**—Under this head are included all those changes in size, shape, and appearance of the abdomen that may take place.

(*a*) *Enlargement, Size, and Shape of the Abdomen.*—At first, during the first six to eight weeks, there is somewhat of a flattening of the abdominal surface, due, doubtless to the descent of the uterus into the pelvic cavity, thus slightly dragging the bladder downward and making traction on the urachus, thereby drawing the umbilicus inward. The navel in consequence becomes depressed; hence the common expression, "A blank before a bank." Later in the fourth month, as the growing uterus rises for proper accommodation in the abdominal cavity, a slight abdominal enlargement will be observed, and the umbilicus is no longer sunken. By the fourth month the fundus uteri has risen about 5 centimeters (2 inches) above the symphysis pubis. The vertical enlargement progresses at the rate of fully two fingers' breadth each four weeks, reaching the umbilicus at the end of the sixth month, and touching the ensiform cartilage at the end of thirty-eight weeks, or eight and a half lunar months (Pl. 19, Fig. 1). The umbilicus for many weeks prior to that time has been protruding. During the last two weeks of utero-gestation the upper portion of the abdominal walls protrudes less and the girth of the woman seems smaller (Pl. 19, Fig. 2). The patient feels more comfortable. The cervical canal is apparently shortened, the child *in utero* has sunken, and the pelvic ligaments are relaxed—changes preparatory to the coming parturition. During this time it will be noticed that the enlarging pregnant womb is symmetrical, smooth in its contour, larger vertically than transversly, and by proper palpation it will be felt to contract spontaneously.

(*b*) *Coloration.*—On inspection of the abdomen of pregnant women there will be recognized not only the condition of the navel, but also a changed color of the abdominal surface, and the presence of striæ, due to distention of the abdomen. The pigmentation may extend from the pubis to the xiphoid cartilage—the brown lines. On the sides of the abdominal walls and down the thighs red, blue, or white markings, like cicatrices, may be seen.

(*c*) *Fetal Movements.*—Fetal movements are generally visible after the sixth month through the abdominal parietes.

7. **Ballottement.**—Ballottement is a passive motion of the fetus, consisting of the peculiar sensation felt by the examining fingers upon giving the fetus a motion *in utero*. Vaginal ballottement is usually employed, although abdominal ballottement is also practicable at times, and may be noticed for a

2 1

1. The non-gravid womb and the same at eight months, with the varying heights of the fundus marked in weeks. 2. Position of the child and the uterus in a case of pendulous abdomen.

longer period of time, even during the beginning of labor. For the ballottement impulse to be perceptible there must be a mobile fetus, not too large, and a sufficient quantity of the liquor amnii to permit the entire fetal displacement *in utero.* The woman stands or reclines during its performance. In the vaginal ballottement the finger is placed within the vagina, anterior to the cervix, the pulp of the finger being applied to the anterior vaginal fornix by a direct brisk motion. The fetus is propelled upward into the uterine cavity, and, falling back by its gravity, an impulse is imparted to the finger against which it falls.

Ballottement distinctly noticed is a pathognomonic sign of pregnancy, there being no other condition in which a solid body is found floating in the uterine cavity. The absence of this sign does not preclude the possibility of pregnancy, for different conditions may prevent its being noticed, such as excessive or great diminution in size of the fetus, hydramnios, multiple pregnancy, some abnormal presentation, or a faulty insertion of the placenta.

Vaginal ballottement can sometimes be practised successfully as early as the latter part of the fourth month. It is more easily recognized in the fifth month, is most distinct in the sixth, continues in the seventh, is doubtful in the eighth, and is absent in the ninth month.

8. **Intermittent Contractions.**—As soon as the uterus is developed sufficiently to be felt by the hand through the abdominal wall, there may be perceptible intermittent uterine contractions which are constantly going on at intervals of a few minutes throughout pregnancy. Purely independent of volition, they may become valuable, in a diagnostic sense, in corroborating other signs. Uterine contractions are not positive signs, because the uterus undergoes somewhat similar contractions to free itself of clots of blood, of polypoid or fibroid tumors, and of retained secundines, or they may be simulated by a distended bladder.

The method of procedure for detecting uterine contractions is to grasp the fundus uteri for from five to twenty minutes, with the patient recumbent on her back, the uterus meanwhile being lifted by the right finger *per vaginam,* the abdominal walls being relaxed by some flexion of the lower limbs. The characteristic hardening will then be felt, the contraction lasting for several minutes. To Braxton Hicks we are indebted for the thorough elucidation of this sign, which is often referred to as "Braxton Hicks' sign of pregnancy."

9. **Quickening and Fetal Movements.**—Quickening is the sensation experienced by the mother as the result of active fetal movements. The period when these active movements are felt is quite uncertain. Usually quickening is considered to occur about the middle of pregnancy, consequently the time of expected parturition is based on this event, but very unreliably. Certain sensations of motion, such as fluttering or pulsating, are sometimes felt by the mother earlier than these active motions. As pregnancy advances these active motions increase in frequency and become more marked, and toward the last they are seen very generally. When felt or seen by the physician, as can be done after the sixth month, fetal movements constitute a very valuable and

positively reliable sign not only of pregnancy, but also of a live child *in utero*. This sign should never be inferred to exist from the statements of the patient. Supposed fetal movements are frequently felt by the patient, and are thought to be, but are not, evidences of pregnancy; frequently they are only illusory. These seemingly fetal motions come from the abdominal walls in false pregnancy or from the intestines in tympanites.

Failure to detect fetal movements does not negative pregnancy, for the child may be dead or its motion may not be felt. To detect these movements, place the patient on her back upon a table or a bed, with the thighs flexed and the abdominal walls relaxed. All clothing should be removed from the abdomen. By palpation and renewed pressure at different parts of the abdomen the active fetal movements may be detected; better, sometimes, by applying the hands to the abdomen, after first wetting them with cold water to excite a reflex action of the fetus.

10. **Uterine Souffle.**—This murmur has been called "placental," because it was thought to be due to the movement of the blood through the placental sinuses; it has also been named the "abdominal souffle," because it was thought to result from the pressure of the gravid uterus on the abdominal vessels. Neither of these two theories is correct. This placental murmur is doubtless due to the movement of the maternal blood through the uterine blood-vessels; hence it should be called "uterine souffle." Heard first in the fourth month, on the sides of the upper part of the uterus, especially the left side, which for obvious reasons is brought nearer the anterior abdominal wall, the murmur is at all times synchronous with the maternal pulsation. It is very uncertain as to its presence, tone, pitch, duration, and location; if once heard, it soon leaves, to return at another time or at another place. It is thus usually heard irregularly as to time, place, pitch, and duration until the end of pregnancy. Uterine souffle is no longer regarded as a certain proof of pregnancy. A sound exactly resembling it is not unfrequently heard in interstitial fibroids of the uterus, and it may be heard when ovarian tumors are present. In the majority of cases of parturition it is heard for the first two or three days in the lying-in state.

11. **Fetal Heart-sounds.**—These sounds are a comparatively modern discovery. Mayer of Genoa first heard them in 1818, in examining the abdomen of a pregnant woman. The fetal heart-sound cannot, as a rule, be heard earlier than the fifth month in utero-gestation. A practised ear may sometimes detect it a few weeks earlier, as in the fourth month. As this sound becomes stronger and louder in advancing pregnancy, its detection in the last few months becomes very easy. The sound may, of course, be quite feeble. If normally vigorous, some non-conducting material, as a tumor, may intervene, impeding its transmission, or there may be a posterior position of the child, thus making it less distinct; hence the inability to hear the fetal heart-sound ought not to negative a pregnancy. When attempts are made for its detection, the room should be quiet and the patient should be in the dorsal posture, with the head on a pillow and the thighs flexed lightly to

the body or extended. The stethoscope ought to be utilized, from motives of modesty, in localizing the sound of the fetal heart. This instrument should be applied to the abdomen below a transverse line passing through the umbilicus, because the head of the fetus is more often lower than the breech. Since the occiput in most instances points toward the left side of the maternal pelvis, the fetal heart-sound is most frequently heard with greatest distinctness upon the left lower space of the abdomen (space D, Fig. 141). If not heard in

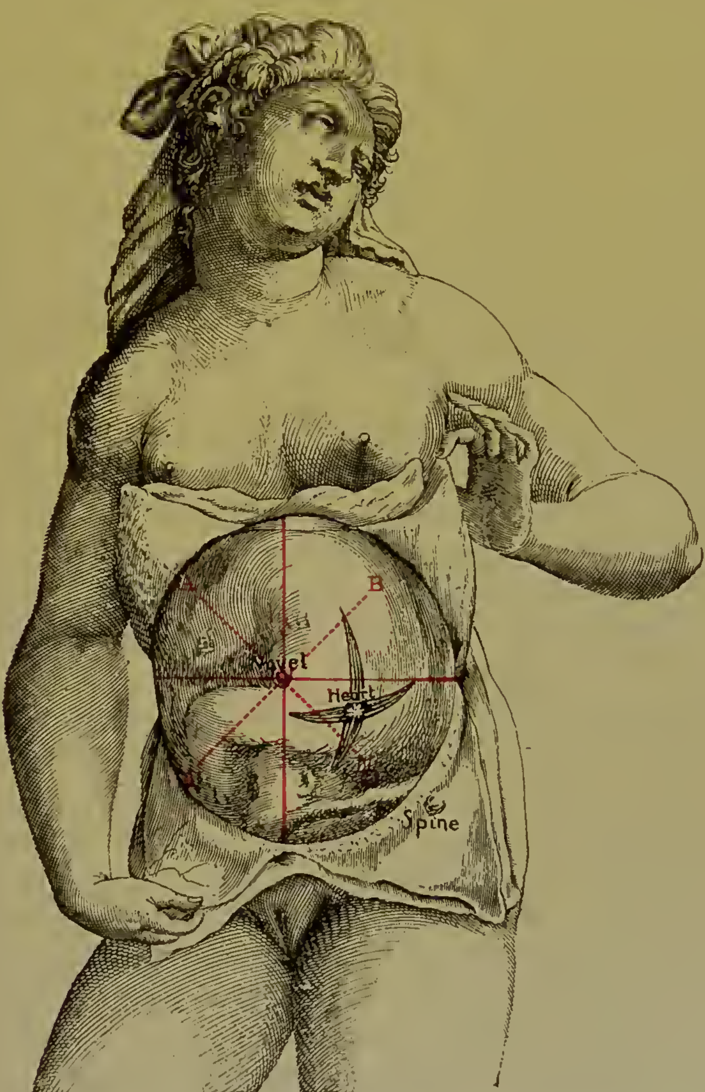


FIG. 141.—Location and intensity of fetal heart-sounds in the left occipito-anterior position (the four quadrants are indicated by the *red* lines; the *pose* is from Spigelius).

this space, search for it should be made over other spaces (as B, C, A). If heard well in regions C, D, the inference is that the head is the lowest part of the fetus, and that the back of the fetus is anterior; if heard best in regions A, B, it is to be inferred that there is a pelvic presentation.

The mean frequency of the pulsations of the fetal heart is about from 135 to 140 to the minute; they are less frequent in large than in small children, and probably are less frequent in males than in females. A temporary variation in their frequency and force is very common. The sound is double and rhythmic, the first sound being more clear and distinct than the second; then comes a brief pause, when the second sound is heard; a longer pause follows before the double rhythmic sound is again heard. The above-mentioned frequency indicates that there is no relation of the fetal heart-sound to the pulsations of the mother's heart. These two sounds are perfectly independent.

Because of the varying frequency of the fetal heart-sounds, attempts have been made to base some reliable predictions as to the sex of the fetus *in utero;* but experience has proven that but little reliance can be placed on such attempts.

The sound of a fetal heart well heard when the uterus is relatively small —too small to accommodate a fetus of five or more months' development— should at once create suspicions of an extra-uterine pregnancy.

As auscultation with the stethoscope reveals the presence of the uterine souffle and the fetal heart-sound, the practised ear may also detect the *funic* or *umbilical souffle*—an intermittent hissing sound synchronous with the fetal heart. It is referable to the umbilical cord. It is heard in but the smallest number of cases, and its causation is conjectural. As a sign of pregnancy it has very little value.

There are also heard sounds produced by active movements of the fetus *in utero.* Fetal movements, for instance, may be heard by the ear instead of being felt by the hand. Their value is significant.

12. **Fetal Contour.**—Inspection of the shape of the abdomen in pregnancy is also valuable; a careful, well-trained touch by palpation may detect the size, shape, and presentation and position of the fetus, as well as, at times, the presence of twins *in utero.*

13. **Mental and Emotional Phenomena.**—Pregnancy quite generally modifies the nature—physical, mental, and emotional—of a woman. At times, she is more vigorous, buoyant, and cheerful than in the non-pregnant state. More generally, however, she is more or less irritable, excitable, and fretful. As the physical appetites for food in quantity, quality, and variety are frequently changed, so also is the moral sense sometimes seriously deranged.

Classification of the Phenomena of Utero-gestation.—The symptoms and signs of pregnancy may now, for convenient study, be classified as to the time of their occurrence. For instance, the nine calendar months of utero-gestation may be divided into three periods, and a classification may be made of the aforesaid phenomena as to these three periods.

First Period of Utero-gestation.—This period comprises the first three calendar months—the time during which the gravid uterus is enclosed within the true pelvic cavity. The *symptoms* are—(1) Menstrual suppression; (2) gastric disorders; (3) mammary changes; (4) vesical irritation. The *signs* are—(1) Beginning patulousness of the os uteri; (2) softening of the infra-vaginal cervix, gradually extending higher; (3) uterus slightly lowered during the first and second months, and anteverted in the third month; (4) flattening of the abdomen, with increasing depression of the umbilicus, the depression gradually disappearing toward the fourth month; (5) violet-colored vaginal walls and cervix uteri; (6) Hegar's sign (compressibility of lower uterine segment), with softened and rounded uterine body.

Second Period of Utero-gestation.—This period embraces the fourth, fifth, and sixth months. The *signs* and *symptoms* are—(1) Menses still absent; (2) subsidence of the gastric disturbances; (3) increasing and progressive development of the mammary signs; (4) vesical irritation improved; (5) the uterus higher, ascending into the abdominal cavity; (6) cervix higher in vagina; navel no longer depressed; (7) fundus uteri two fingers' breadth above pubes at the end of the fourth month; at the umbilicus toward the end of the sixth month; (8) cervix more softened and patulous; (9) fetal active motion (quickening) experienced toward the end of the fourth or in the fifth month; (10) ballottement detected, becoming more distinct; (11) intermittent contractions also detected, increasing in force; (12) uterine souffle audible in the fourth or fifth month; (13) fetal heart-sounds easily detected, usually first in the fifth month.

Third Period of Utero-gestation.—This period embraces the seventh, eighth, and ninth months. The *signs* and *symptoms* are—(1) Menses continue absent; (2) gastric symptoms slight or only occasional; (3) further progressive development of the mammary signs, colostrum sometimes present; (4) uterus continues to rise in the abdominal cavity, reaching midway between the navel and the ensiform cartilage at the end of the seventh month; reaching the ensiform cartilage in the first two weeks of the ninth month; after which period it gradually becomes lower; (5) ballottement continues until the eighth month, when it is doubtful; it is absent in the ninth month; (6) umbilicus commencing progressively to protrude; (7) vaginal cervix seemingly shortened, more thickened, softened, and patulous, getting higher; (8) fetal movements felt or seen after the sixth month; (9) in last two weeks the fundus uteri, having reached its maximum height and size, begins to descend, when the cervix undergoes an apparent shortening. Now the cervical lips become thinner. The presenting part of the fetus, having partially entered the pelvic inlet, is more easily detected by vaginal touch. Pressure-symptoms of the chest and the stomach disappear, though edema of the limbs and the genitals may show themselves.

Relative Value of the Symptoms and Signs of Pregnancy in Point of Diagnosis.—Very properly we may classify all the symptoms and signs of pregnancy as medical evidence of the presumptive, the probable, and the positive kind. They naturally rank in value inversely in the order named.

The presumptive evidences of pregnancy are—(1) Menstrual suppression; (2) morning sickness; (2) irritable bladder; (4) mental and emotional phenomena.

The probable evidences are—(1) Mammary changes; (2) the bimanual signs; (3) abdominal changes in size, shape, and color; (4) changes in cervix uteri in size, shape, consistency, and color; (5) uterine murmur; (6) intermittent contractions.

The positive signs are—(1) Active movements of the fetus; (2) passive movements of the fetus (ballottement); (3) fetal heart-sounds.

Differential Diagnosis of Pregnancy.—Nothing can be of greater moment, on the one hand, than a correct diagnosis of pregnancy, and on the other of the many conditions simulating pregnancy. Not only does a correct estimate of the actual condition concern the patient and her family in a physical, mental, or moral sense, but the professional reputation of the physician is also seriously involved. The legal and social relations of some pregnancies possess a deep and painful interest; therefore let no opinion be expressed in any case until a reasonable certainty can be arrived at. Time may be needed to clear up all doubts.

As pregnancy implies a certain variable amount of abdominal enlargement after the fourth month, its existence must necessarily be differentiated from the many other conditions, physiological and morbid, that are attended with the same sign. In the differential diagnosis not much difficulty need exist after this enlargement is fairly well advanced. Most mistakes are doubtless made when the gravid uterus is still within the pelvis; there is then often much doubt. There will first be considered the differential diagnosis of pregnancy and the morbid conditions simulating it during the first three months. Just here comes into play the diagnostic value of the sign so forcibly elucidated by Hegar. The peculiar shape of the uterus in the second and third months of pregnancy (see p. 164) is not simulated by anything else. While in a measure resembling subinvolution of the uterus, it is to be remembered that in this morbid condition there is an organic enlargement uniform in all directions. In chronic metritis attended with hyperemia, with or without flexion, the uterus is not jug-shaped, and the elasticity and compressibility of its uterine walls are absent. Chronic metritis attended with parenchymatous hyperplasia of the uterine body, shows the uterine walls dense, hard, sensitive to touch, not elastic, doughy, or boggy. An interstitial fibroid in either uterine wall is dense, hard, and uneven. Doubt is apt to pertain to cases of pregnancy associated with chronic retroversion, but then a careful analysis of the presumptive symptoms will always be helpful in differentiation. A clear study of the physical signs of the cervix and the corpus uteri as to color, size, shape, and consistency are of inestimable value in the first three months. A search for Hegar's and the other bimanual signs ought never to be neglected. Pregnancy may be concealed, feigned, and imagined. These possibilities must be considered and be cleared up.

When pregnancy has created material abdominal enlargement, the diagnosis ought to be differentiated from all other conditions attended by the same sign, such as ascites, ovarian tumor, uterine fibroid, distended bladder, tympanites, pseudo-cyesis (false pregnancy), enlarged uterus from gas (physometra) or from water (hydrometra), retained menses (hematometra), obesity, enlarged abdominal viscera, malignant disease, etc. In differentiating these conditions the three positive signs of pregnancy should always be borne in mind.

In ascites fluctuation is most distinct; the resonant note on percussion is always changed in location according to the position of the patient. Cardiac, hepatic, or renal disease can usually be detected as a causative factor of the ascites, and the symptoms of pregnancy are absent.

In ovarian tumor a fluctuation of the abdomen is also present, though less distinct; the abdominal enlargement has come on more slowly and has a peculiar shape. Menstruation is ordinarily present, and the signs—intra-pelvic and abdominal—of pregnancy are entirely absent. The area of dulness and tympanites is not essentially altered by posture. As pregnancy and an ovarian tumor quite often coexist, a constant watch ought to be made for this possibility in every case of an abdominal enlargement. The presence of two tumors of different consistency with an intervening sulcus is quite significant; when both are present, the uterus itself by a vaginal examination shows enlargement, and there are present the presumptive symptoms of pregnancy, while there are also the signs of an ovarian cyst.

A uterine fibroid creates an abdominal enlargement which is more firm, hard, and dense than any of the above-mentioned conditions; it is nodular and very often asymmetrical, is quite slow of growth, and menstruation is not only present, but, as a rule, is also increased in quantity and lengthened in duration. While the uterine murmur may be very well marked, there are present no positive signs of pregnancy.

A distended bladder is of comparatively short duration, is attended with much discomfort, is associated with dribbling of the urine, and is quickly relieved by the use of a catheter.

Fecal accumulation is dissipated by a copius rectal enema and free catharsis.

Tympanitic distention of the abdomen is always very resonant on percussion, is variable in size on different days, does not fluctuate, and quickly disappears by proper treatment.

Pseudo-cyesis, or false pregnancy, occurs oftenest toward the menopause, and its false appearances are quickly unmasked by the administration of an anesthetic.

Obesity shows the abdominal walls soft, doughy, and easily palpated between the fingers of either hand, and there are no intrapelvic signs indicative of pregnancy.

Hydrometra and physometra are extremely rare. There is always with them an absence of most of the probable and all the positive signs of pregnancy. The uterus in both diseases enlarges more slowly, and never to the extent of an advanced pregnancy.

Diagnosis of Extra-uterine Pregnancy.—A judicious differential diagnosis of intra-uterine pregnancy implies a careful consideration of the possible or probable existence of extra-uterine pregnancy. This is especially the fact when the gravid uterus or the extra-uterine sac is still within the true pelvis, for if the diagnosis is the best guide for treatment, now is the time of all others to know the exact condition of affairs. The following symptoms and signs are worthy of most reliance from a diagnostic point of view. When extra-uterine pregnancy exists, there are—

1. The general and reflex symptoms of pregnancy; they have often come on after an uncertain period of sterility. Nausea and vomiting appear aggravated (Winckel).

2. Then comes a disordered menstruation, especially metrorrhagia, accompanied with gushes of blood, and with pelvic pain coincident with the above symptoms of pregnancy. Pains are often very severe, with marked tenderness within the pelvis. Such symptoms are highly suggestive.

3. There is the presence of a pelvic tumor characterized as a tense cyst, sensitive to touch, actively pulsating. This tumor has a steady and progressive growth. In the first two months it has the size of a pigeon's egg; in the third month it has the size of a hen's egg; in the fourth month it has the size of two fists.

4. The os uteri is patulous; the uterus is displaced, but is slightly enlarged and empty.

5. Symptoms No. 2 may be absent until the end of the third month, when suddenly they become severe, with spasmodic pains, followed by the general symptoms of collapse.

6. Expulsion of the decidua, in part or in whole.

Numbers 1 and 2 are *presumptive* symptoms of extra-uterine pregnancy; Numbers 3 and 4 are *probable* signs of extra-uterine pregnancy; Numbers 5 and 6 are *positive* signs of extra-uterine pregnancy.

Some of the above-mentioned symptoms resemble those of early abortions. In all cases with the history of a supposed abortion, when an intrapelvic mass is then or afterward felt, there should be suspicion of an extra-uterine pregnancy. In consideration of the possibility or probability of extra-uterine pregnancy, based on the detection of a lateral extra-uterine sac, we are necessarily obliged also to exclude in the differentiation a small ovarian tumor, an enlarged ovary, a hydrosalpinx or a pyosalpinx, and pelvic exudates (cellular or peritoneal). A distinct sulcus between the sac or the tumor and the uterus may be a physical sign to guide in the diagnosis. The symptoms of a severe and overwhelming pain are quite generally manifested by the end of the third month, because most cases are tubal in some form. These symptoms are not noticed when the extra-uterine pregnancy is entirely abdominal. The possibility of mistakes in diagnosis is to be considered with reference to—(*a*) Retroflexion of the gravid uterus; (*b*) pyosalpinx with amenorrhea, or causing abortion; (*c*) malignant tumors of the abdomen with ascites; (*d*) normal pregnancy complicated with abdominal tumors; (*e*) coincident intra- and extra-uterine pregnancy; (*f*) pregnancy in a deformed uterus.

Diagnosis of Multiple Pregnancy.—Suspicions of a twin pregnancy are rarely excited; but the presence of multiple pregnancy may be conjectured from the following data: (*a*) Very large size of the abdomen; (*b*) exaggeration of the results of a gravid uterus; (*c*) irregularity of abdominal enlargement; (*d*) detection by palpation of the abdominal walls of two fetal heads and other parts of fetuses; (*e*) ballottement imperfect or impossible; (*f*) fetal movements distinctively felt in different parts of the abdomen; (*g*) recognition by auscultation of two fetal heart-sounds, not synchronous with each other and heard at different locations, with an intervening space where the heart-sounds are heard feebly or not at all.

Diagnosis of a Prior Pregnancy.—In the earlier months the diagnosis of any previous pregnancy must always be obscure, even if search has been made for evidences of a previous pregnancy within a few days after the expulsion of the uterine contents. Of course we would expect to find the uterus more or less enlarged, some local hyperemia of it, the os uteri patulous, and there may be present some lochial discharge. But these distinctive differences between the uterus which has suffered an early abortion within the first three or four months and the chronically-enlarged uterus menstruating are not sufficient to be surely reliable. In case of death a post-mortem examination would probably throw much light on the question of gestation. In an aborted uterus some remains of the placenta or of the decidua might be detected, the placental site would be imperfectly involuted, and in the ovaries the corpus luteum of pregnancy might be found.

The physical evidences of a previous pregnancy are most distinctly marked when parturition has occurred late during pregnancy or at term. The uterus by palpation in the hypogastric region is then felt much larger; the lochial discharge is more characteristic; a fatty degeneration can be detected in the uterine walls; the placental site will be well marked; the vagina is patulous and relaxed; the corpus luteum of pregnancy is quite distinct. Should the cervix uteri or the perineum have been lacerated in the previous parturition, they will be observed either ununited or secondarily healed. The vulvar fourchette is always destroyed after the first delivery. Very often—quite generally, indeed—unmistakable proof of a previous pregnancy and delivery is noticed by vaginal touch. An inspection of the cervix uteri shows that the os is oval, with imperfectly-healed rents. A careful examination after death will show the same condition, and the cervical canal will be found less fusiform; the uterus is enlarged and heavier, the corporeal cavity having lost its clearly-defined triangular shape, the fundus uteri being no longer convex, as in a nullipara, but flat or concave.

All general appearances of recent deliveries are very uncertain; there are none which may not be produced by other conditions. Some women look perfectly well after a delivery, and one unacquainted with the clinical history would never suspect that parturition had occurred. Inspection of the abdomen is more to be depended on. A soft and relaxed abdominal wall, with the skin thrown into folds, traversed by white shining lines (lineæ albicantes) extending from the groin to the navel, is strong probable proof of recent delivery. The breasts after the first few days are fuller, are tumid, and they contain the lacteal secretion. The presence of colostrum-corpuscles bespeaks a recent delivery. The nipples show the characteristic areolæ.

Chloasma uterinum usually occurs on the face of pregnant women, and lasts for many years. But the same skin affection is also met with in single women, and even in men. It is due to physiological and pathological changes in the uterus and to various disorders of the menstrual functions.

Diagnosis of the Life or the Death of the Fetus.—The fetus may from some cause, maternal or fetal, die *in utero* before its time of viability. Such a death generally shows itself sooner or later by certain maternal symptoms. The patient has a feeling of languor and physical depression, with impaired appetite; there will be noticed a furred tongue, nausea, vomiting, and a pale and sallow color of the patient. Chilliness with some fever is sometimes observed. The abdomen does not progressively enlarge; the breasts become flaccid and diminished in size; and a fetid discharge from the vagina, containing exfoliated epidermis, is a certain but not common indication. The absence of the fetal heart-sounds, especially if once heard, and the cessation of active motion of the child, once felt, if pregnancy has advanced beyond the sixth month, are positive proofs. Should the fetal head have presented, its scalp becomes soft and flabby; the cranial bones are loose and movable, overlapping one another. The lips of the fetal mouth in face presentations become flabby and motionless. No caput succedaneum can form in delivery, for there is no fetal circulation to assist in its production. Large quantities of meconium may be discharged, although the breech does not present. Should the breech present, the examining finger discovers that the anal sphincter of the fetus will not spontaneously contract. The umbilical cord, prolapsing in shoulder or other presentations, is cold, flaccid, and pulseless, contrary to its warm, full, and pulsating condition during fetal life.

The rapidity of maternal infection from retention within the uterus of a dead fetus will depend upon her vital resistance, the condition of her general health, and—the most important factor—whether or not the membranes have been ruptured and atmospheric air has entered the uterine cavity.

2. Duration of Pregnancy.

Parturition or childbirth means the end of pregnancy. The end of pregnancy, or the time of expected labor, is always important to foretell, not only for the physician's but also for the patient's sake. Cazeaux has given expression to the statement that conception is more apt to follow when a voluptuous sensation or a general erethism occurs during or following coitus; but this cannot be true. Many women are always passive in coitus, and all women are entirely passive in conception.

The normal duration of pregnancy is nine calendar months or about ten lunar months. To be more exact, its duration is between two hundred and seventy and two hundred and eighty days, from the first day of the last occurring menstrual period, or about two hundred and seventy-five days, calculated from its cessation. Various methods have been suggested to obtain the time of the expected parturition; the most reliable of these methods is as follows: Determine the exact day at which the last menstruation appeared. Count forward nine months, or, better, count backward three months, and then add seven days. Irrespective of the time of the year from which this count is begun, a very close approximation, from two hundred and seventy-eight to two hundred and eighty days, is obtained. This is the rule; but it is uncertain and exceptions are not uncommon. Many difficulties are experienced in determining the date of the expected parturition. As most pregnancies occur in married women, we cannot base any calculations on a single act of coitus. Even if there has been but one coitus, all physiologists admit that there is a variable period in different women, and in the same woman at different times, between insemination and the fertilization of the ovum.

When the impossibility of ascertaining the precise time of fertilization and the probable variation in the length of gestation itself are considered, the reasons for this uncertainty become apparent. Recognizing with His that the moment of fecundation marks the beginning of pregnancy, the possibility of fixing this occurrence becomes of great interest. The uncertainty becomes still greater owing to our inadequate knowledge as to the length of time during which the sexual elements, the ova and the spermatozoa, retain their vitality after liberation from their respective sources.

While the exact time during which the matured but unfertilized ovum retains its power of successfully receiving the male element is unknown, the observations conducted on lower animals render it probable that the ovum is capable of impregnation at any time during its sojourn within the oviduct and before reaching the uterus, or, probably, for a period of about one week from its escape from the Graafian follicle.

The remarkable vitality of the spermatozoa even under far less favorable conditions—direct observation showing that these elements retain their movements for over nine days outside the body—renders it almost certain that their powers of fertilization are maintained for a long time after they are deposited within the healthy female generative tract; the assumption of His, Hausmann, and others that the spermatoza are capable of fertilization after their sojourn of three or more weeks within the oviduct is well founded.

Consideration of these facts renders apparent the impossibility of fixing with certainty the beginning of pregnancy, since conception may result from the union of the ovum liberated at the commencement of menstruation with the spermatozoa introduced toward the end of the period; or it may result, as pointed out by His, from the meeting of the male elements already within the oviduct with an ovum discharged a day or two before the occurrence of the menstrual phenomena. The possible discrepancies arising from these causes have been represented graphically by Marshall as follows:

I., 2, 3, 4, 5, 6, 7 . . . . 26, 27, 28, II.

in which I. is the first day of the last actually occurring menstrual period, and II. is the first day of the first *omitted* period. Should pregnancy, however, occur under the conditions regarded as possible by His—that is, by the fertilization of an ovum precociously discharged just prior to the first omitted period, a discrepancy of over three weeks would appear between the actual termination of pregnancy and the estimated date of labor, when calculated in the usual manner from the first day of the last occurring menstruation. The general consensus of opinion, however, regards the time immediately following the menstrual period as that most favorable for fertilization, the upper third of the oviduct being probably the locality where fecundation most usually takes place.

Should impregnation have occurred following the menstrual period, the next expected period will almost certainly be absent; but if it has taken place within a few days before an expected period, the expected flow may not physiologically be suspended, but simply be diminished in quantity or be shortened in duration. The prediction of the date of labor from the last menstruation is likewise very unreliable in all women in whom its previous occurrences have been irregular or uncertain in time.

Quickening, as a rule, is noticed by the female in the fourth month—about four and one-half months—and it is not unusual for counts to be made from this period. But as quickening (active movements of the child) is felt at uncertain times, this rule has been found to be very fallacious. At a certain time it proves to be the most reliable of any rule for adoption—namely, when menstruation has physiologically been suspended by an intercurrent lactation. Then there is no last menstrual period to count from, and we have but to add four and one-half months to this time of quickening to determine the approximate time of the expected labor.

It is no wonder that the duration of pregnancy in the human female has been such a fruitful topic for discussion among obstetricians. Not only the moral character of a woman, but also the legitimacy and the hereditary rights of a child, may depend upon a fair solution of this question. Is it possible for a woman to give birth to a child ten, eleven, or twelve months after the death or the continued absence of her husband? is a medico-legal question concerning which the obstetrician may be called upon to express an opinion. Experience with some of the lower animals in whom the date of a single coitus is well fixed, and the records made by numerous distinguished obstetric authorities, make such exceptional instances as reliably creditable. Most of such offspring are very large male children.

3. Prolongation of Pregnancy.

Sir Charles Clark in 1816, when giving his evidence in the famous Gardner-Peerage case before the House of Commons, said: "I have never yet seen a single instance in which the laws of nature have been changed, believing the law of nature to be that parturition should take place forty weeks after conception." Many physicians of the present day hold that the law of nature is quite fixed in this respect—that human pregnancy never exceeds this term. But we have now sufficient evidence to show that human pregnancy is not so definitely and precisely fixed as some think. The duration of pregnancy may be shorter or longer than 280 days.

To what extent may pregnancy be prolonged, and what are the evidences of its prolongation? It is easy to understand the moral and legal aspects of this important question. The moral character of the female, and the inherited rights and legitimacy of an offspring may depend on a fair and just fixation of its paternity, and on the determination of the possibility of the prolongation of human pregnancy, as when a woman gives birth to a child ten, eleven, or twelve months after the death, or the forced absence, of the husband. Laws on this question vary in different countries. In France legitimacy cannot be contested until 300 days have elapsed since the death of the husband, and in Austria and Prussia about the same time is allowed. In England and in the United States no time is fixed.

Numerous cases are on record of a prolongation of pregnancy to 336, 332, 324, and 319 days, respectively, after the last menstruation. Granting that conception in these cases did not take place within a few days after the last menstruation, as is the rule, but was postponed to just before the first missed period of that function, we can subtract about 23 days from these periods of gestation, and will then have 313, 309, 301, and 296 days, each exceeding the ordinary duration of pregnancy.

Admitting that the first menstrual cessation was due to some abnormal cause—a mere possibility—we will still have a prolonged duration of pregnancy. Hence the possibility of a variation of a conception being uncertain as to time does not account for the great variation in gestation so often observed. It is extremely uncommon in healthy young women for a menstrual period to be skipped for one time only without there being some noticeable change in the bodily health.

Variations in the duration of pregnancy occur in cows, in which there have been careful records of a single coitus. When impregnation occurs in the human female as the result of a single coitus, the date of which is accurately recorded, as among single women or among married women whose husbands have been absent for months, possible errors of the date of conception may be avoided. If, then, pregnancy is at times prolonged, to what extent is there any protraction? Meigs, Atlee, and Simpson have mentioned instances when the duration was prolonged to almost or quite a year. Dewees records a case which was prolonged to ten calendar months. Playfair, Lusk, and Leishman mentioned cases of considerable prolongation. Taylor and Beck in their work on Medical Jurisprudence record numerous instances of protracted gestation.

Other physiological functions of life, such as dentition, puberty, or menstruation, may vary as to the time of occurrence. Some women appear to go uniformly beyond the usual time for parturition. The degree of uterine activity must be less with them. More frequently the sex of the forthcoming delayed child is male rather than female. We are forced, then, to the conclusion, by a study of the analogy of other functions of the body, by observations in the lower animals, and by accurate reliable data, from women in particular, to believe that pregnancy may be, and often is, prolonged. Gestation may be lengthened, parturition may be delayed, from a few days to several months.

The causes which conduce to labor—the maturing of the decidua vera, its preparatory disintegration, and the final detachment of the membrane of the ovum from the uterine lining—do not always occur at the same time or with the same degree of activity; hence gestation may be prolonged.

III. HYGIENE AND MANAGEMENT OF PREGNANCY.

Hygiene of Pregnancy.—To be carried safely through the period of utero-gestation, the most critical time of her life, physiologically speaking, the pregnant woman needs special care. Particular attention is to be given her in the selection of diet, exercise, rest, sleep, clothing, and bathing. Her mental condition is to be watched; her attention diverted. The condition of the breasts calls for some prophylactic treatment.

Diet.—Very early in pregnancy the desire for food is diminished and certain unusual articles of food may be craved. Fair quantities of food are always needed. Respect must be paid to her morbid longings in taste. Thus the time, place, and social association in partaking of food, and its kind and variety, are always to be considered. The morning sickness is thus sometimes best abated. In the fourth month the gastric irritability usually spontaneously subsides, the appetite reappears, and the digestion improves. All foods, animal and vegetable, that are reasonably well digested and nutritious are best suited to her condition. In a word, the diet of a pregnant woman should be plain, simple, easy of digestion, highly nutritious, and partaken of at regular intervals. A good general supply of nitrogenous food, with vegetables and fruits, is called for. No inflexible rules can be made for all cases. As some foods do not agree equally well with all patients, personal likes and idiosyncrasies must be consulted. A generous diet improves hematosis, increases functional activity, augments body-weight and body-heat, imparts tone and firmness to the blood-vessels and tissues, and diminishes the susceptibility of the nervous system to pain and reflex irritation. That the diet must directly influence the growth and development of the fetus *in utero* is reasonably clear.

In the latter part of pregnancy the gravid uterus has risen to and presses upon the stomach, hence food has to be taken in greater moderation and at shorter intervals. A milk diet is at times especially needed. Albuminuria is a condition calling for the use of milk, as recommended by Tarnier. Its absolute use, strictly enforced, gives very good results in this complication.

Exercise.—Moderate exercise can almost always be well borne. Violent exercise and excessive fatigue are invariably to be avoided. Extraordinary exercise, such as riding horseback or over rough roads, dancing, or lifting heavy weights, is injurious. Long journeys by water or by land should be postponed if possible.

Is parturition made more easy by unusual physical exercise? Affirmatory opinions have been entertained. Doubtless, women whose habits have accustomed them to considerable physical exercise can, all things being equal, undergo parturition easily and quickly; but those unaccustomed to any special physical exercise should undertake only what can comfortably be borne. If active exercise is not well borne, then passive exercise may be highly beneficial. Riding in the open air gives the pregnant woman the necessary fresh air and sunlight. Crowded and ill-ventilated rooms are to be avoided.

While moderate exercise is needed in many or in most cases, its continuance is objectionable in cases where the normal relaxation of the pelvic joints becomes excessive. The pubic joints, most often affected, are so relaxed at times that locomotion is impeded and rest is demanded.

Rest.—A pregnant woman needs abundance of sleep, because of its health-giving, restoring influence. A portion of each day, after the mid-day meal, may well be selected for the assumption of the recumbent posture, to obtain for an hour or two either rest or sleep.

Clothing.—Great care is to be taken that the clothing is so adjusted as not to compress the abdomen and the chest. While the quantity and the quality of the clothing are to be determined by the season of the year, the garments placed around the waist are to be as light as practicable consistent with comfort. The clothing is best suspended from the shoulders. The corset and tight-fitting skirts are injurious, impeding as they do the expansion of the growing uterus and its contents, and favoring the development of symptoms of a not uncommon complication of pregnancy—albuminuria with uremia. Multiparæ with relaxed abdominal walls often experience comfort by giving support to these parts with an abdominal bandage, thereby maintaining the uterus in a more normal position, wherein there is better accommodation of the fetus. All possible pressure of the pelvic and renal veins is to be removed.

Bathing is to be administered to the body at the usual intervals observed in health—daily in warm weather, and at least twice a week in cold weather. The baths are to be general, with an abundance of water and soap. The temperature of the bath may be either warm or cool, according to previous habits and to the season of the year. The functional activity of the skin, quite often impeded in the last weeks of pregnancy, should be maintained carefully by the free use of the bath.

Vaginal injections are not required if there is no leucorrhea, vaginal or uterine. If an injection is given because of this complication, there is nothing better than a saturated solution (one quart) of boric acid given with a fountain syringe in a very gentle current.

Sexual intercourse is to be regulated carefully, for very often it is found to be injurious to pregnant women. While especially enjoyed by some pregnant women, coitus is distasteful to most women at this period, and it becomes the source of much pelvic discomfort to not a few; it may create an abortion. Even uncivilized nations have condemned the privilege of sexual intercourse during the period of pregnancy, and have visited punishment on the offender. During the first few months of pregnancy, when so many abortions occur, and toward the last of pregnancy, it is best for the husband and wife to occupy separate beds.

May *local treatment* to the diseased cervix and canal be carried on during pregnancy? With proper precautions and due care, this question is answered in the affirmative. Most of the accidents causing the induction of abortion by local interference have arisen from a neglect to investigate and determine the condition of the body of the uterus, and to ascertain whether it may have been gravid. Pregnancy aggravates chronic cervical endometritis in that it increases the cervical catarrh, the granular degeneration, the secondary vaginitis, and the vulvar pruritus. By the gentle use of warm vaginal injections of a uniform temperature, and by the topical use of astringents and emollients, and in rarer cases of the nitrate of silver in solution, not only may the patient be made more comfortable, through an improvement in the local condition and the arrest of reflex disorders, such as nausea and vomiting, but parturition itself may also be made easier.

The mental condition of pregnancy is always important to consider. Emotional susceptibility is usually somewhat increased. The pregnant woman, quite excitable and irritable, readily responds to external influences by which, in the non-gravid condition, she would not be influenced. Sometimes she feels unusually well, is intellectually brightened and more active, takes greater interest in her household affairs, and says she is positively happier. At other times a certain despondency creeps over her mental state; she is unusually morose; there is observed irritable moodishness or peevishness beyond the control of the will; the senses of sight, hearing, smell, and taste, and the sensory or motor nerves, are frequently perverted without any structural changes in the nerves concerned. All these perversions or exaltations of function are doubtless directly or indirectly attributable to the quantitative and qualitative changes of the blood from pregnancy, and to the physical changes going on in the sexual organs, creating reflex disorders. Structural alterations in the growing fetus may be effected, modified, or perverted by psychical influences. Certain fetal disorders may result from maternal impressions. Monstrosities do at times so occur.

Physiologists admit, and observations prove, that the maternal emotions do affect the development of the exterior of the fetus. Likewise may the mental development be altered in its complex and delicate organization. Idiocy may so result. The mind influences and modifies the body in ways unexplained.

In view of these facts the wise physician should aim to direct the mental condition of his patient. While all sudden unpleasant news, frights, and physical shocks are carefully to be avoided, those circumstances which improperly harass the pregnant woman are to be dismissed. Kind assurances are ever helpful. A judicious amount of amusement is not to be forgotten. The mind is to be occupied pleasantly, and diverted into new, pleasing, surprising channels, into associations agreeable and cheerful. Around the patient should be thrown a gentle, protective care, and she should ever be treated with considerate kindness. It becomes the duty of the husband to give his wife an intelligent co-operation to bear her burden.

Management of Pregnancy.—It becomes the duty of every practitioner of medicine engaged to attend a woman in an expected parturition not only to give her some general hygienic directions as to diet, dress, exercise, and the regulation of her bowels and skin, but also in a general way he should assume some professional care of her throughout her pregnancy. Many disorders and complications are apt to arise during this period, and much depends upon prompt and well-directed advice in their judicious management.

First of all, the stomach disorder most frequently occurring calls for some attention. Reference has been made to its dietetic management, more efficacious, it may be, than the medicinal. In this connection the writer has realized general good results from the administration for a time of koumiss. Failing with the retention of the food on the stomach, rectal administration of food is next to be utilized. For the physiological nausea and vomiting of pregnancy the writer has found the following remedies efficient: Tincture of nux vomica, weak solutions of atropia, sodium bromid, cocain, and electricity. Faradization (secondary current) of the stomach and the dorsal spine, and galvanization of the central sympathetic are worthy of a more extended use for this affection than they have yet received.

Next, the alvine evacuations are to be maintained daily. A good diet and regularity of habits show their good results. The mineral waters, such as Congress, Hathorn, the sulpho-saline waters, or a solution of phosphate of sodium or Carlsbad salts or the Seidlitz powders, are indicated. Purgation is seldom called for. The best laxative remedies are aloein, podophyllin, and cascara sagrada.

Above all, it is important that careful attention be given to the renal function. Once a month at least, during the latter half of pregnancy, should the physical, chemical, and microscopical elements of the urine be ascertained, to detect any possible alterations in its quantity and quality. Not a few cases of puerperal eclampsia from uremia may thus be averted or be modified by a supervision of the kidney excretion. "To be forewarned is to be forearmed" was never better illustrated than just here. Albuminuria is present in at least from 5 to 10 per cent. of the cases of pregnant women; some claim that the proportion is larger.

A careful examination of the abdomen may very properly be made after fetal viability. The external examination by palpation, together with an internal vaginal examination, is called for in all cases toward the last two weeks of pregnancy, to determine not only the fetal viability and a possible multiple pregnancy, but also to ascertain the presentation and position of the fetus *in utero*, the existence of any complications, as hydramnion, and to appreciate the cervical condition in shape, size, and patulousness, in order more correctly to estimate the time of the approach of the expected parturition. The pelvis of every woman should be examined by external and internal pelvimetry in the seventh or eighth month of pregnancy, if in her first pregnancy or if she has had any special difficulty in a previous parturition. At the time of this examination directions may be given as to the preparation of the room, the bed, the garments, and as to obtaining all needed articles.

The exact methods of diagnosis that prevail in maternity hospitals ought also to exist in private practice. If the labor promises to be long, difficult, or very painful from obstructions of any kind, the obstetrician ought to know it in advance, that he may elect at a proper time before parturition whether to choose the induction of a premature labor, to depend on the use of the forceps, or to resort to a podalic version, a symphysiotomy, or a Cesarean section. How many craniotomies could thus be avoided and maternal deaths prevented !

The mammary glands need ample room for their development to prepare them for the coming function of lactation. The nipples, especially if retracted, should always be drawn out by the application of the index finger and the thumb for a few minutes each day during the last six weeks of pregnancy. Exposure of the glands and the nipples to the air doubtless tends to diminish their tendency to become sore and fissured. Daily ablutions with cold water are always essential. A topical application of the following as a prophylactic remedy for sore and fissured nipples is to be recommended when it is thought desirable to use an astringent application :

℞. Tannin,	ʒj ;
Glycerinæ,	℥ss ;
Aquæ rosæ,	℥ss.—M.

Sig. Apply daily as directed.

As no two pregnant women are alike, and as no two pregnancies in the same woman are alike, no absolute rule can be framed for all. The expectant treatment is largely called for. Discretionary powers are necessarily given the physician in charge. Only general principles can be laid down for guidance. Special directions are called for when there are special disorders and complications. A very frequent danger is that an abortion or a premature delivery may be precipitated by uterine contractions. Any constitutional disease, especially syphilis, may require special medication. Doubtless there are remedies which often favor uterine tonicity and become prophylactic against abortions. Viburnum prunifolium, aletris, and cimicifuga doubtless favor the normal completion of gestation. In all cases as little medicine as possible ought to be given. Pregnancy is a purely physiological condition, and it is best managed by an observance of the hygienic instructions.

IV. THE PATHOLOGY OF PREGNANCY.*

I. Diseases of the Several Systems.

The remarkable changes occurring in the genital organs of woman, and also throughout her entire body, as gestation advances, occasion conditions which often transcend the bounds of health and become states of disease. As these changes are most pronounced in the uterus and its appendages, it will be appropriate to consider, first, the pathological conditions of the uterus and its appendages induced or exaggerated by the pregnant state. It will then be proper to study those general derangements which the condition of pregnancy invites; next in order, to treat of the influence of the various infectious agents upon the pregnant organism; and finally, the surgical injuries and processes observed during this period.

1. Pathological Conditions of the Uterus and Appendages.

The Uterus during Pregnancy.—While the position of the pregnant uterus is subject to frequent change, it has been found by Ferguson[1] and others to be rotated to the right in 80 to 90 per cent. of all pregnant women. Great distention of the bladder may temporarily lessen the degree of rotation upon its axis. Occasionally this dextro-torsion becomes excessive, as in a case reported by Wenning,[2] in which the uterus at six months' pregnancy was so strongly rotated toward the right as to simulate extra-uterine pregnancy upon that side. The left tube was greatly enlarged.

The term "hypertrophy" best describes the normal condition of the pregnant uterus in the various phases of gestation: its peritoneal covering, its interlacing muscular and elastic tissues, and its glandular lining membrane, all become enlarged by production of new elements from nuclei already existing. The enormous increase in area and in blood-supply is especially remarkable in the pregnant woman: although the deciduous membranes represent the greatest development of its epithelial elements, still the endometrium shares extensively in the general hypertrophy. It is readily seen that this condition of plethora naturally favors the rapid development of any neoplasm previously existing in the uterus, especially any neoplasm whose elements closely resemble normal uterine structures; such neoplasms are—

Myomata of the uterus, sometimes termed fibro-myomata or uterine fibroids. As has been shown by Croom[3] and others, although myomata exist frequently among childbearing women, they do not always attract attention during pregnancy, and are often undetected at labor. Such tumors grow,

* The *superior* figures ([1]) occurring throughout the text of this article refer to the bibliography given in the Reference List on page 313.

however, with great rapidity during pregnancy, often interfering with the circulation in the lower extremities. Many cases in which early pregnancy is complicated by edema of the legs, and in which abortion occurs at four or five months, accompanied by profuse hemorrhage, are cases of fibroids complicating pregnancy: their bulk causes interference with the functions of the bladder and the rectum, while they alter the position of the uterus, causing abnormal presentations of the fetus and prolapse of the cord at labor. Their encroachment upon the uterine muscle interferes with its normal contraction and retraction; hence the rhythmic contractions of the uterus commonly existing during pregnancy are unusually painful, and sometimes are excessive in strength. The substance of the uterus may be so altered that rupture of this organ may occur, as in a case described by Hogan,[4] where a fibroid pregnant uterus ruptured spontaneously at about the fourth month of gestation. When rupture does not take place, spontaneous reduction of a displaced fibroid uterus sometimes results from the stimulus to growth and intermittent contractions furnished by pregnancy. Spontaneous reduction is frequently followed by rupture of the membranes and abortion, as pointed out by Loviot.[5] Although fibroid tumors of the uterus are often supposed to prevent conception, cases are on record where sterility persisting for some years in such patients had been replaced by pregnancy so late as forty-five years of age.[6] Pregnancy exerts a remarkable influence upon fibroid tumors of the uterus, not only in causing their rapid growth, but also in frequently bringing about a condition of well-marked softening and fatty degeneration: this pathological condition sometimes decides the choice of a method of treatment in these cases.

The treatment of pregnancy complicated by fibroid tumors when interference is necessary is by operative procedure. Submucous tumors, if they become pedunculated and distend the lower uterine segment, frequently present before the fetal head, and, exciting premature labor, may be removed by the obstetrician in advance of the child. Intramural tumors require no treatment during pregnancy unless the results of their pressure upon important viscera oblige the obstetrician to perform hysterectomy. Subserous fibroids in the pregnant patient may often be removed without terminating the pregnancy, as in cases reported by Frommel[7] and others. Should extensive fibro-cystic changes in the uterus occur, complicating pregnancy, this condition should not be allowed to go on to term, but hysterectomy should promptly be performed.

Routier[8] reports a successful myomectomy during pregnancy, and he has collected, with his own, 15 cases in which the operation was performed, ten of which recovered. Strauch[9] also reports the successful removal of a fibroid as large as a goose-egg from a pregnant uterus by abdominal section. Phillips[10] gathered reports of 282 cases of fibroids complicating pregnancy: his statistics indicate a high mortality from radical procedures. Pozzi,[11] from his collection of these cases and his personal experience with them, considers simple myomectomy the preferable procedure in suitable cases.

The occurrence of spontaneous abortion sometimes necessitates immediate operation in cases of pregnancy complicated by fibroid tumors; thus Bourcart[12] reports the case of a pregnant patient whose gestation was complicated by myoma of the uterus and by excessive torsion of the uterus and its appendages. Spontaneous abortion was followed by chill and fever. Taking advantage of a fall in the temperature, Bourcart performed hysterectomy. The result was successful. Attention has recently been called by Hofmeier [13] to the influence which myomata exert upon pregnancy in causing abortion. He cites from the records of others 796 cases of pregnancy with this complication, and finds that abortion occurred in 6.9 per cent. of the cases. He naturally concludes that the majority of patients who suffer from myomata during pregnancy pass through gestation but slightly influenced by the tumor of the uterus.

Ott reports a case of pregnancy nearly at term complicated by fibromyoma of the uterus and bronchitis.[14] Amputation of the uterus was performed; the stump was covered with peritoneum and dropped. The patient and her child made a good recovery.

Gordon [15] reports a successful myomectomy by which a fibroid was removed from the anterior wall of the pregnant uterus: although the uterine wall was left thin and vascular, hemorrhage was controlled by stitching the peritoneum and the base of the wound with fine catgut. Recovery was rapid and pregnancy was uninterrupted.

Staveley [16] collected a considerable number of cases of fibroid tumors complicating pregnancy, and he adds from the records of the Johns Hopkins Hospital two cases in which myomectomy was performed successfully during pregnancy without interrupting gestation. Staveley's tables embrace 33 cases with a maternal mortality of 24.25 per cent. Statistics show that in late years myomectomy for this condition is more successful than before antiseptic surgery attained its present perfection in technique. During the last eight years the mortality-rate of myomectomy in these cases has fallen to 11.75 per cent.*

Cancer of the uterus, complicating pregnancy, increases in cases of carcinoma with great rapidity during the pregnant state, and with even greater vigor during the puerperal condition. When pregnancy has not advanced beyond the fourth month, Van der Veer [17] and others practise vaginal extirpation of the uterus. In cases where carcinoma attacks the cervix the prognosis is most unfavorable. If delay is practised, the tissues surrounding the cervix soon become infiltrated, and delivery by abdominal section, should life persist to full term of pregnancy, is the only alternative. The fact that carcinoma grows with greatest rapidity during the puerperal condition obliges the obstetrician, whenever possible, to perform complete extirpation of the uterus, either at the time when the fetus is delivered or as soon as possible thereafter. The danger of septic infection following Cesarean section is so great that the majority of operators prefer hysterectomy or total extirpation.

Cancer occasionally involves the uterine tissue so extensively as to result in rupture of the uterus. This extensive involvement occurs in cases where preg-

* The literature of this subject given on page 313 will interest those who desire to pursue it further.

nancy supervenes upon the existence of the cancerous condition. The great stimulus which pregnancy causes in malignant growths results in the rapid dissemination of malignant tissues, which gradually destroy the elasticity and the resisting power of the muscular layers of the womb. Rupture occurs in these cases during abortion or during labor at term. The prognosis is exceedingly grave, for, even should the patient rally immediately from the rupture, the malignant growth must sooner or later end her life.

Auvard reports the case of a patient in her eleventh pregnancy who had uterine cancer for two years.[18] Labor was exceedingly slow, the pains being very weak but persistent. When partial dilatation was present the os was incised in several directions and the fetus was found in breech presentation. Extraction by the feet was performed, and persistent hemorrhage ensued; on examination the uterus was found ruptured transversely at the upper edge of the lower uterine segment. The patient succumbed to shock.

Cancerous infiltration of the tissues of the cervix often necessitates multiple incisions in any necessary manipulation during pregnancy or at labor. Von Herff[19] illustrates the value of free incisions in cancerous cases. Cesarean section had been decided upon, but, as a last resort, multiple incisions were freely made, and they proved efficacious. Early pregnancy complicated by uterine cancer invariably demands total extirpation, from which even unfavorable cases recover and the operation has prolonged life, as illustrated by Möller.[20] In his patient the cancerous uterus was extirpated with great difficulty by reason of the infiltration of surrounding tissue. A rent was left in the peritoneal cavity, through which rent a loop of intestine protruded. Notwithstanding these unfavorable features, the patient made a good recovery, and some time after the operation was comparatively free from cancer. Sutugin reports two cases of amputation of the uterus at term for cancer, in each of which cases the life of the child was saved. Taylor of Japan records[21] a very unfavorable case of cancer in which vaginal extirpation was performed with great difficulty. A favorable result followed.

In cases where the cervix only is involved the diseased tissue should at once be removed by the knife and cautery, with the hope that the progress of the disorder may be checked temporarily while the pregnancy advances, thus affording the child a better opportunity for life. In carcinoma of the pregnant uterus complete extirpation is the only treatment that promises a favorable result. If the patient is seen for the first time in pregnancy advanced beyond the fourth month, delay may be advised in the interest of the child so long as the tissues about the uterus do not become involved. Under the improved methods now followed in performing total extirpation the prognosis for the mother is no longer desperate, a fair chance for recovery from the operation and the prolongation of life being thus given her.[22]

In **epithelioma of the cervix** complicating pregnancy, Edis[23] reports a case in which an epitheliomatous mass was found involving nearly the whole cervix and extending down upon the posterior vaginal wall, rendering the passage of the fetal head impossible. The child was delivered by Cesarean section, and seven months after the operation the epithelioma had made but little progress.

The decidual lining of the uterus may occasionally become the seat of malignant disease, as observed by Sänger and Chiari.[24] This form of cancer is described by these writers as a true sarcoma of the decidua: its symptoms are foul discharge and hemorrhage persisting after labor, and its fatal termination usually occurs within six or seven months after delivery. Metastatic deposits are not uncommon, the cells of which bear the characteristics of decidual cells. There is an innocuous form of this growth, also described by Sänger,[25] that is not to be mistaken for decidua remaining adherent after a former pregnancy.

Hypertrophy of the decidua occurring during pregnancy may be non-malignant and not dependent upon the existence of syphilis; thus, Hermann[26] describes cases of decidual hypertrophy in which the tissue measured one-fiftieth of an inch in thickness: microscopic examination revealed the presence of large cells, with large nuclei, five or six in number, without intercellular substance, but infiltrated and containing leucocytes. A similar condition has also been described by Virchow,[27] Strassman,[28] Dohrn,[29] Gusserow,[30] Klebs,[31] and Matthews Duncan.[32]

Spontaneous rupture of the uterus occasionally happens during pregnancy. Such cases are usually found to have been complicated by a fibroid tumor or by displacement of the uterus, with adhesions binding it in its displaced position. Manipulation intended to replace the uterus has sometimes hastened its rupture; thus in a case reported by Dickey[33] the patient was in the third month of her fifth pregnancy: an effort had been made to replace a retroverted womb, the effort causing the patient considerable distress. A few days afterward something was felt to give way, and the patient perished in a few hours from shock. Post-mortem examination showed early pregnancy and the uterus ruptured transversely from one Fallopian tube to the other.

Spontaneous rupture of the uterus may result from the rapid development of a large fetus in a uterus whose tissues have been weakened by previous disease. The fetus may escape into the abdominal cavity, as illustrated in a case reported by Madurowicz,[34] in which fatty degeneration of the uterine wall at the junction of the fundus and cervix was found. The fetus had become partially encapsulated. Purulent peritonitis ensued, and the abdominal wall opened spontaneously with the discharge of pus. The patient died of exhaustion.

Endometritis during pregnancy results from an aggravation of a pre-existing inflammatory condition, and it is a familiar and frequent cause of early abortion. In patients who complete the period of gestation the existence of this condition may be suspected when occasional discharges of blood or of watery mucus occur. While the pregnancy is not likely to go to term, still its continuance must not be despaired of because of these discharges. An endometritis set up or aggravated by pregnancy not infrequently causes adherence of the membranes about the cervix and the lower uterine segment, often complicating labor by premature rupture of the bag of waters and protracted dilatation of the birth-canal. It is noticed in women who conceive shortly after an abortion that an endometritis arising at the abortion may persist throughout pregnancy, becoming aggravated, and resulting finally in the firm adherence of the placenta and in complicated labor; thus, Löhlein[35] reports a case of this character in which the pregnancy went to term, its latter portion being complicated by intermittent pyrexia and by a very firmly adherent placenta.

The treatment of this condition is entirely in the interest of the mother, as the prospect of her retaining the ovum to maturity is so slight that exhausting hemorrhage or febrile disturbance should lead to the prompt emptying of the uterus : this should only be done in the most thorough surgical manner and under strict antiseptic precautions. Sufficient dilatation to permit the use of the sharp curette and of drainage should be secured by using the fingers or solid metal dilators. Should septic infection and fever be present, the blunt-edged douche-curette may be employed to great advantage, thoroughly emptying the uterus under a stream of antiseptic fluid. Where sepsis and fever are absent the sharp curette followed by antiseptic irrigation will be found efficient. Drainage with iodoform gauze, with repeated intra-uterine irrigation, is indicated, should fever and foul discharge continue. Curetting is best performed at the time of abortion or premature labor, or, if this opportunity is omitted, it should be done when the patient has recovered strength and the interior of the uterus has ceased to furnish a foul discharge.

Salpingitis existing during pregnancy complicates the pregnant condition largely by reason of the adhesions and the inflammatory exudates usually present with the salpingitis. As the uterus increases in size, tension upon these adhesions causes very considerable pain, and if the adhesions are firm, binding down the uterus, abortion is not infrequently the final result. A frequent cause of retroversion and retroflexion of the gravid uterus is to be found in salpingitis and in the adhesions and exudates which accompany this condition; in such cases obstinate nausea and vomiting, and finally abortion, may be the direct consequence of the salpingitis present.[36 37] Salpingitis is by no means a trifling complication of pregnancy, as cases are recorded in which acute sepsis, with general peritonitis developing twenty-four hours after labor, has caused death. It is certainly true that a patient suffering from salpingitis should avoid pregnancy, and should subject herself to prompt and thorough treatment if the liability to pregnancy exists.

Diseased conditions of the ovary complicating pregnancy are usually made worse by the gravid condition; thus, ovarian cysts, solid tumors of these organs, and inflammatory conditions are greatly aggravated during pregnancy. Acute oöphoritis complicating pregnancy is of rare occurrence, and it may result from an exacerbation of a chronic process or septic infection from a previous abortion. Three cases of this affection are reported by Coe;[38] in each of two cases tubal and ovarian abscess formed and was emptied. All three patients recovered, although convalescence was prolonged. The treatment of this condition is largely expectant, abdominal section being most successful before the fifth month of pregnancy.

Thomson[39] has shown that while the tubes undergo a marked hypertrophy during pregnancy, the ovary itself does not. The alterations observed in the ovaries during pregnancy are caused by foreign growths, and not by the increase of elements normally present. In addition to the danger of abortion which the size of an ovarian tumor occasions, there is possible risk that such a tumor may twist its pedicle, and that gangrene may be added to the complications of labor in this condition. It has repeatedly been shown that the operation of ovariotomy is safe and satisfactory during pregnancy, and this fact calls for the removal of ovarian tumors as soon as their presence is detected. In these cases adhesions are not often present, nor does the pregnant condition predispose to their formation.

The rapid development of a cystic condition of the ovary may completely mask an early pregnancy, as in a case reported by Polaillon,[40] in which pregnancy could not positively be diagnosticated until a cystic ovary and an adherent tube were removed. This operation did not interfere with the pregnant condition, the patient going to term and being delivered of a healthy child.

Spontaneous cure of a pelvic cyst complicating pregnancy occasionally happens in the case of broad-ligament cysts, which disappear by spontaneous rupture. Ruge[41] describes a case four months pregnant in which under anesthesia a pelvic cyst was pushed up above the brim of the pelvis, relieving pressure upon the uterus. Abortion followed, and after recovery the abdomen was opened; no cyst was found, and its disappearance is ascribed to spontaneous rupture. The evidence in favor of the operative treatment of ovarian cysts complicating pregnancy is greatly in the ascendant over any other form of treatment; this is shown by the results of Schroeder and Olshausen, Flaischlen[42] and Dsirne;[43] the mortality of the operation ranges from 9.8 per cent. to 5.9 per cent.

Mangiagalli[44] and Acconci[45] similarly report good results from ovariotomy during pregnancy.

Terrillon[46] advises against puncture of ovarian cysts during pregnancy, and urges ovariotomy not earlier than the third nor later than the fifth month.

Disorders of the vulva may occur during pregnancy as the result of mechanical injury or be associated with some constitutional condition. Hematoma of the vulva is especially likely to happen by reason of the congested condition of the parts caused by pregnancy. An illustrative case is reported by Ehrendorfer:[47] incision under antiseptic precautions and tamponing, preferably with iodoform gauze, resulted in speedy cure. Pruritus of the vulva is one of the most annoying complications of the pregnant condition. In cases where there is no reason to suspect the neglect of cleanliness, pruritus is to be considered as due to one of two classes of causes. The first class comprises the many diseases which alter profoundly the condition of the skin; chief among these are disorders of the digestive and excretory systems, as diabetes and nephritis. The treatment of the pruritus in such cases resolves itself, first, into the treatment of the general condition, and then into such local applications as may be found of use. The latter embraces the various antiseptics and anesthetics which are available in the practice of dermatology. The second class is those cases in which no diseased condition of the general organism can be found to account for the pruritus, and in which the disorder is purely local. This class is treated by local applications, and in obstinate cases resection of the diseased tissues may prove the only alternative. Sänger[48] has shown that in these cases partial or total extirpation of the vulva is thoroughly legitimate, and should include the removal of the glans clitoridis. Where the entire vulva is affected plastic operation may be necessary to cover surfaces exposed in the extirpation. In circumscribed pruritus of the vulva it may be possible to limit the extirpation to the affected part.

Elephantiasis of the labia may complicate pregnancy, and prove an annoyance to the obstetrician at the time of labor. The appended illustration (Fig. 142) is taken from a case under the observation of, and described by, the writer. The patient, who was pregnant for the first time, gave no history of venereal disease; the growth persisted for several months before the occurrence of pregnancy, and increased slowly during gestation. Aside from its bulk it occasioned no suffering. During labor it rendered thorough vaginal examinations difficult, and at the moment of delivery impeded somewhat the dilatation of the birth-canal. Especial precautions were taken to maintain the parts in an antiseptic condition at the moment of delivery. The patient's convales-

FIG. 142.—Elephantiasis of the labia (one-fourth life size).

cence was uninterrupted, as no serious wound of the hypertrophied tissue occurred during the labor. During the puerperal period the injured tissue decreased very slightly in size.

The presence of bacteria in the genital tract of the healthy pregnant patient is an interesting question which has occasioned extensive research. The results go to show that pathogenic bacteria are not present in the healthy pregnant patient. Among the most thorough of such investigations are those of Winter,[49] made at the suggestion of Schroeder: he found that the Fallopian tubes contained normally no micro-organisms: this is also true of the normal uterine cavity. In half the uteri examined germs were present at the internal os; in the secretion of the cervix, and also in the vagina, there were found abundant micro-organisms. These germs were found to be pathogenic, but not possessing the virulence which characterizes them when observed amid tissues in a pathological condition. It was found, however, that when pathogenic organisms were introduced from without the germs already present in the genital canal assumed a virulent character.

Diseased conditions of the vagina occasionally complicate the pregnant condition; thus, Rissman[50] reports a case in which a polypoid degeneration of the connective tissue of the vaginal wall attained such proportions as to prolapse before the fetal head during labor and to offer an obstacle to delivery; in this case the condition was accompanied by gonorrheal infection.

Vesico-vaginal fistula caused by pressure in a previous labor may become a serious complication at labor, by reason of the thickened condition of the tissues about the fistula and the excessive pain which pressure occasions.[51]

Displacements of the pregnant uterus are not infrequent, often causing great discomfort, and sometimes seriously complicating and even terminating pregnancy. If the patient has already borne children, the supports of the uterus are frequently so weakened that when repeated pregnancy ensues displacement readily occurs.

The most frequent uterine displacement complicating pregnancy is retroversion of the gravid uterus: this produces the usual symptoms, pain and dragging sensation in the back, interference with the functions of the rectum and often of the bladder, and a sensation of weight and heaviness relieved only by the recumbent position upon the side or the assumption of the knee-chest position. On vaginal examination the os and cervix are found directed upward and forward, and the fundus of the uterus is below the promontory of the sacrum. In uncomplicated cases, where no peritoneal adhesions exist binding down the uterus, retroversion of the pregnant womb is a comparatively simple matter. As the uterus increases in size the womb gradually rises in the pelvis, until at four or five months it passes above the brim and remains permanently in the abdominal cavity.

The treatment of uncomplicated retroversion of the pregnant uterus consists in supporting the womb by tampons of antiseptic wool smeared with an antiseptic ointment. A preparation containing 10 grains of powdered boracic acid to the $\frac{1}{2}$ ounce each of lanolin and vaselin is most useful in these cases. Once in four or five days such a tampon should be removed and the vagina be irrigated gently with warm water or with a saturated solution of boracic acid. A Sims speculum should then be used, and the pelvic floor

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be drawn downward and backward, when a tampon of antiseptic wool, rolled into a shape fitting the pelvic floor, should be introduced and carried across from side to side, putting the utero-sacral ligaments slightly upon the stretch and raising the fundus of the uterus. Such tampons have the great advantage over the hard-rubber pessary that they create no irritation, support the uterus comfortably, and mould themselves perfectly to the contour of the parts. Their use, however, requires discrimination in fitting the tampon properly, and calls for regular supervision of the physician at comparatively frequent intervals. Cases are occasionally met with in which it is impossible for the patient to have the services of a physician except at intervals of several weeks: it is then often advantageous to fit a carefully-moulded hard-rubber pessary which shall raise the uterus to its proper level. It is often asserted that such a pessary may cause abortion: the fact, however, remains that it is not a well-fitting pessary that produces abortion, but it is the displacement of the uterus resulting from a lack of such support as the pessary should give. Cases of habitual abortion caused by displacement of the womb are not infrequently cured by raising the pregnant womb.

Many cases of retroversion of the uterus are associated with chronic pelvic peritonitis, and are complicated by prolapse of one or both of the Fallopian tubes and of the ovaries, and the presence of adhesions binding the displaced organs in their artificial situation. With these patients the pain as the uterus increases in size is very distressing, and results from traction upon adhesions which occasionally yield, greatly adding to the patient's comfort. In other cases the separation of these peritoneal adhesions is accompanied by very considerable shock, which simulates to some extent the shock of rupture of the sac in tubal ectopic gestation. In still other cases these adhesions are so firm and tense that spontaneous separation of them is impossible, the womb remaining fixed in the position it occupied at the time of the original peritoneal inflammation. The continued growth of the uterus may so stretch these adhesions as to enable the womb to rise into the abdominal cavity. Should the peritoneal surfaces not yield, however, a retroverted and incarcerated uterus will be the result, and, as the fetus increases in size, the adhesions not yielding, abortion is inevitable; and should fresh septic infection occur and the patient survive, her condition will be aggravated by fresh adhesions, and chronic invalidism will result.

The frequency of this complication may be estimated by the report of Martin,[52] who found in 24,000 women 121 cases of retroversion and retroflexion of the uterus persisting during pregnancy. In 27 of these cases the deformity was congenital, and one case is cited in which a patient suffered for three and a half years with congenital retroflexion and with gonorrhea, but conceived after recovery from the gonorrhea. Sterility in cases of congenital retroflexion depends upon a diseased endometrium or diseased condition of the tube, and not upon the congenital deformity. In 94 of the cases the retroversion persisted after repeated pregnancies. Nine of these patients wore pessaries at the time when conception occurred. The most significant symptom which drew the patient's attention to the backward displacement of the uterus, and for which she sought medical aid, was dysuria. When spontaneous restitution fails no time should be lost in accomplishing the same by instrumental means. That retroflexion and incarceration of the pregnant uterus is a serious condition may be inferred from the report and collection by Treub of 50 cases of death from this cause.[53]. He found that out of the 50 deaths, thirteen were from uremia, eleven from rupture of the bladder (Fig. 143), six from sepsis; ten followed peritonitis and cystitis; three were caused by pyemia, two by rupture of the peritoneum, and five cases followed accidents occurring during an effort to replace the uterus.

These statistics have recently been amplified by Gottschalk,[54] who collected 67 deaths from backward displacement of the pregnant uterus, the immediate causes of which he describes as follows: Uremia and collapse, sixteen cases; septicemia arising from the bladder, four; gangrene of the bladder, three; rupture of the bladder, eleven; peritonitis from disease of the bladder, seventeen; pyemia, three; rupture of the peritoneum and vagina, two; improper efforts at reposition, five; gangrene of the intestine and peritonitis, one; occlusion of the intestine, one; and four cases in which the immediate cause of death is not described. Gottschalk in his paper reports an interesting case under his own observation in which the retroverted pregnant uterus produced intestinal occlusion without ileus. He performed abdominal section, but was unable to save the patient.

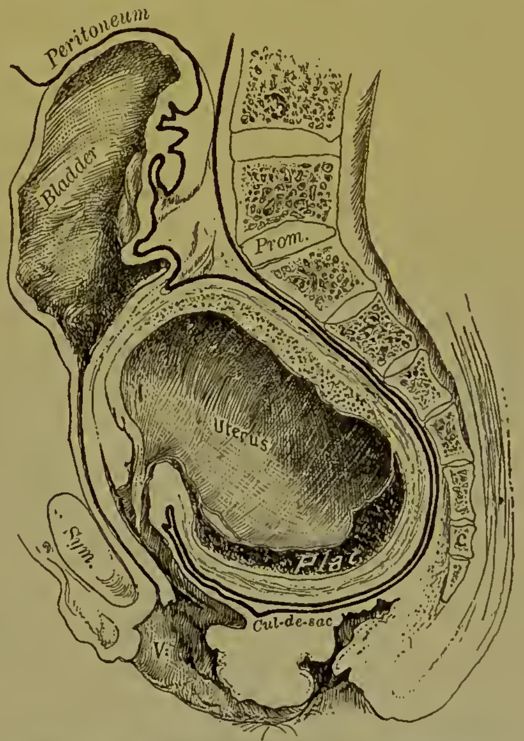

FIG. 143.—Frozen section of retroverted uterus of three and a half to four months. Death from rupture of bladder (*Arch. f. Gyn.*, Band 41, Taf. 8, f. 1).

Ectopic gestation may be simulated by a retroverted pregnant uterus, as in a case reported by Barbour,[55] in which the physical signs of retroversion in the pregnant uterus were perfectly present. In the treatment of this condition Cohnstein,[56] in treating five severe cases of incarceration of the pregnant uterus, first emptied the bladder by a stiff catheter, and then drew down the cervix and vaginal wall with a tenaculum, while the cervix was pressed backward by downward pressure behind the symphysis. While the cervix was drawn downward and backward by a tenaculum the fundus was raised with the free hand of the operator.

Retroversion of the pregnant uterus is occasionally found complicated by the existence of disease of the pelvic bones; in these cases the pelvic deformity is often such that spontaneous restitution of the uterus is impossible. It is then necessary to relieve the patient by operative means, and, as a last resort, to extirpate the uterus *per vaginam* if possible. An interesting case of osteomalacia complicating retroflexion of the gravid uterus is reported by Beuckiser;[57] efforts had previously been made to produce abortion and to puncture the fetal sac through the posterior vaginal wall.

The treatment of retroversion of the pregnant uterus when adhesions are present must be conducted with great caution. A gentle effort should be made to stretch the adhesions, gradually allowing the womb to regain its lost position: this is best accomplished by the use of the antiseptic wool tampon, combining with it an alterative application which shall aid in the absorption of exudates in the pelvis and shall loosen adhesions. At present a favorite remedy for this purpose is ichthyol, as follows:

Ichthyol,		℥j;
Lanolin,		
Vaselin,	*āā*	℥jss.

An ointment stronger in ichthyol is occasionally employed with good results. Once or twice weekly the patient may take, with advantage, a hot vaginal injection if this be practised very gently. In cases of sudden and severe abdominal pain with great shock occurring in patients in the early months of pregnancy and with retroverted uteri prompt incision of the abdomen, with assiduous examination of the pelvic organs, may result in finding a small focus of infection or a ruptured adhesion, which can be dealt with successfully by surgical means. If such adhesions do not yield, abortion is inevitable, and especial precautions must be taken that septic infection is prevented in uteri so bound down.

The fact that hematosalpinx or pyosalpinx very frequently accompanies such peritoneal adhesions indicates the danger of rupture of such accumulations and of acute septic infection which may follow. Should such rupture occur, evidenced by pain in the abdomen and symptoms of shock, the abdomen should be opened at once, the parts be carefully inspected while the patient is in the Trendelenburg posture, and all foci of infection should thoroughly and completely be removed. With free irrigation with saline fluid and drainage it is possible that such a patient may escape general infection of the abdominal cavity.

2. General Disorders of Pregnancy.

The urethra, bladder, and ureters share during pregnancy the condition of increased vascularity and irritability that characterizes the pelvic organs. The bladder in early pregnancy is less capable of distention antero-posteriorly, and hence enlarges laterally as gestation goes on. In the latter months of pregnancy the uterus rises in the abdomen, drawing the bladder with it above the pelvic brim; this seems a conservative provision to protect the bladder from injury by pressure. The bladder accompanies the uterus in the displacements frequently seen during pregnancy. The urethra becomes elongated as the uterus rises in the pelvis. The urethra may become completely or partly occluded in some of the uterine displacements observed during early pregnancy. If the displacement of the uterus be not corrected, there follow over-distention of the bladder, paralysis of its muscular layer, and decomposition of the retained urine, with erosion, ulceration, and final perforation.

Cystitis and hematuria complicating pregnancy demand rest in the recumbent posture, and if the inflammation of the bladder be gonorrheal in character, its careful treatment is strongly indicated. Labor in such cases, by making traction upon pelvic adhesions, may compress the ureters, favoring the development of uremic poisoning and eclampsia. Subinvolution of the uterus is very apt to occur in such cases, while the inflammation of the urinary tract may become chronic. Diphtheritic inflammation of the bladder is seen in cases where an incarcerated uterus prevents the passage of urine and where a catarrhal condition of the mucous membrane has previously been present. In cases where during pregnancy the germs of gonorrhea have been retained in and about the urethra, labor, by reason of the pressure and disturbance of the parts which then occur, may cause migration of these germs. Cystitis is the first result of such added infection, and later this infection travels up the ureters to the kidney, and acute parenchymatous nephritis may be the result: this whole process occupies several weeks for its full development and consummation, and its issue is usually fatal, the patient perishing from septicemia.[58]

The Kidneys during Pregnancy.—There is abundant evidence to show that the kidneys share with the other viscera the congested and hypertrophied condition common during pregnancy. This peculiar engorgement of the kidney has given rise to the term "kidney of pregnancy." Much discussion has been elicited in the effort to differentiate the "kidney of pregnancy" from beginning nephritis. It is evident that only the systematic and microscopic examination of the urine can accurately determine whether simple congestion is present, or whether the kidney is being damaged in its essential elements, the secreting cells of the tubules. When such study of the urine finds only hyaline casts, crystals of various sorts, and the slight epithelial *débris* which may be found in healthy individuals, there is no reason to believe that nephritis exists; but when, on the other hand, epithelial, granular, or fatty casts are persistently present, the diagnosis of nephritis can scarcely be denied. It is upon such comparative examinations that a diagnosis must be based, and not upon the mere presence or absence of serum-albumin. Attention has recently been called by Trantenroth[59] to a condition of beginning fatty degeneration in the kidney which causes no symptom in the urine, and which may suddenly become so acute as to destroy the patient by sudden kidney failure. Infective process as present in these cases is so far wanting, and patients thus affected, if they survive pregnancy, do not become nephritic afterward. An acute inflammation of the kidney cannot be caused by pregnancy, and is only observed in the rare cases where infective bacteria find entrance to the genito-urinary tract of the pregnant. This condition of congestion during pregnancy is increased during labor, and renal albumin is present during the progress of labor in considerable amount. Patients suffering from diseased kidneys and becoming pregnant have the kidney disorder greatly aggravated, often to a fatal issue. The causes of this condition, known as the "kidney of pregnancy," are the increased intra-abdominal tension to which all the viscera are subjected; disturbances in the nutrition of the kidney through an altered condition of the blood of the pregnant patient; and an engorgement of the spermatic veins and ureters by mechanical pressure. It is possible for eclampsia to develop without lesion of the kidneys, although in most cases of eclampsia a diseased condition of the kidneys can plainly be discerned. Fischer, in studying the same subject,[60] found in 70 cases evidence that the "kidney of pregnancy" was present in fifty-eight; eight cases of nephritis occurred among the 70 patients. Fischer found red blood-corpuscles in considerable amount in cases where acute nephritis occurred. Granular and epithelial casts indicated chronic nephritis. The occurrence of chronic endarteritis accompanying chronic nephritis explains the rupture of blood-vessels within the uterus and the intra-uterine hemorrhage which sometimes destroys these patients. Schauta[61] describes a typical case of fatal hemorrhage in which chronic interstitial nephritis and degeneration of the muscle of the heart and uterus were found. The life of the child was also sacrificed.

X Albuminuria is of such frequent occurrence during pregnancy as scarcely to require serious consideration, except as a symptom in connection with others of nephritis. Among others, Meyer[62] from an elaborate study of this subject at Copenhagen found albuminuria in 5.4 per cent. of pregnant women. Casts accompanied the albumin in 2 per cent. This may be taken as an indication of the relative frequency of kidney involvement in cases manifesting albuminuria. As pregnancy advanced, albumin became more abundant until during the last thirty days but 28.9 per cent. of urine examined was free from albumin. Premature births occurred in 8 per cent. of patients with albumin, and in 21.5 per cent. of patients who had casts in the urine. He adds other clinical details which emphasize the significance of the presence of casts as indicating nephritis. X Lantos[63] in the clinic at Budapest found albumin so frequently in pregnant patients that he considers it physiological during pregnancy and a diagnostic symptom of the condition. Herman calls attention in this[64] and in other papers presented at the Obstetrical Society of London to two conditions of renal disease in the pregnant woman: one is acute kidney failure with extreme diminution in the quantity of urine and deficiency in the excretion of urea, which quickly ends fatally if the excretion of urea is not re-established. The other process resembles interstitial nephritis in its slow course and ultimately fatal termination. The interesting fact that a patient may have uremic convulsions during pregnancy without eclampsia is illustrated by Boudin,[65] who describes a patient seven months pregnant admitted to the hospital unconscious with uremic convulsions. On establishing the secretion of urine and purging the patient, consciousness returned, and the following day a seven months' fetus was stillborn. Symptoms of uremia supervened, but recovery finally ensued. The patient manifested no symptom of eclampsia and had no edema. The very interesting question of the prognosis in nephritis during pregnancy has recently received consideration at the hands of Koblanck.[66] In a series of 77 patients, 59.7 per cent. showed nothing pathological in the urine after their recovery from labor; 16.6 per cent. manifested slight involvement of the kidneys as shown by hyaline casts and leucocytes, with a trace of albumin; in 15.4 per cent. a catarrhal condition of the urinary tract was evidently present; in 6.5 per cent. the patients were the victims of nephritis.

The presence of sugar in the urine during pregnancy has been the subject of investigation by Berberoff:[67] his tests were thorough and minute, and his results were largely negative, a trace of sugar being present in some patients in early pregnancy, and disappearing as labor approached. Polyuria may be observed in the pregnant patient without a pathological condition of the urine, as in a case reported by Voituriaz.[68] Among the most significant of the symptoms presented by pregnant patients suffering from nephritis may be reckoned albuminuric retinitis. Abundant evidence of the significance of this complication is afforded by the literature of ophthalmology upon the subject. In a recent paper Randolph[69] reports 5 cases, with a pathological study and drawings of the tissues involved: he regards visual disturbances occurring in the first six months of pregnancy, associated with violent headache, as very significant of albuminuric retinitis. If this condition be found, to save sight pregnancy should at once be terminated. Visual disturbances during the last seven weeks of pregnancy are of less grave import. The occurrence of renal retinitis in one pregnancy does not necessarily mean its recurrence in a succeeding pregnancy.

The treatment of disorders of the urinary tract occurring during pregnancy necessitates, first, a careful examination of the position of the uterus, inasmuch as pressure upon the bladder, ureters, and kidneys by a displaced pregnant uterus is so frequently a cause of disease. A retroverted uterus should be raised and be supported in proper position by tampons of antiseptic carded wool. Cystitis may be treated by douching the bladder with creolin or lysol, 30 drops to the pint or quart of warm water, as the patient's tolerance will permit. The administration of salol, of boracic acid, or of sodium salicylate internally is also of advantage. If the ureters become involved, catheterization of these ducts, the bladder having first been rendered aseptic, is indicated to determine which kidney is affected if pyelitis is present. Should this procedure show the presence of pus and bacteria in one kidney, the extirpation or the drainage of this organ is indicated. Such disorders, however, complicating pregnancy, are unfavorable and dangerous to the life of the patient. Should recovery occur, the patient is liable, after the birth of the child, to become the victim of some form of chronic nephritis.

Suppurating hydatid of the abdomen is an infrequent but dangerous complication of pregnancy. The diagnosis is made by the presence of an abdominal tumor not attached to the uterus, and by the contents of this tumor obtained through tapping. An incision should be made through the abdominal wall, and the edges of the sac of the tumor be sewn to the edges of the abdominal incision. So soon as adhesion has taken place the cyst should be opened and its contents thoroughly removed. Pregnancy is not necessarily interrupted by this complication.

Peritonitis during pregnancy,[70] as has been stated, results in most cases from previous inflammation of the endometrium, the Fallopian tubes, or the connective tissue of the pelvis, caused by septic germs or their spores. There remain, however, cases in which no infection can be traced, but in which sudden exposure to cold or to dampness may produce rapidly-extending and fatal peritonitis; thus, instances are recorded where a cold bath taken while the patient was overheated, and accompanied by the drinking of cold fluid, was followed by rapidly-developing and fatal general peritonitis.

Mechanical injury or a severe strain may be followed by peritonitis in a pregnant patient. Gow[71] reports the case of a patient advanced in pregnancy who slipped through a hole in the floor of a building; peritonitis supervened; the patient was delivered by version, but ceased breathing during delivery. Abdominal incision disclosed no blood in the peritoneal cavity, but lymph was found upon the peritoneum and uterus. No evidence of rupture of the uterus or other organ was discovered. No focus from which the inflammation could have begun was found upon examination.

Concealed accidental hemorrhage is among the most dangerous complications of pregnancy. One of the most extensive recent collections of such cases is that by Storer,[72] who contributes an account of 46 in his own observation, and adds the collection of 84 cases by Goodell and 23 by Braxton Hicks, making a total of 153: 46.7 per cent. of the mothers perished, and of the children 94 per cent. Of 63 cases which received no treatment, 64 per cent. died, while in 79 cases in which the condition was detected and treated, 29 per cent. died. It is thus apparent how insidious is the danger and how difficult is its recognition in these patients. There is contributed by Jardrin[73] a further series of these cases, the results of which differ in no particular from those observed in the more extensive series of Storer. As so much importance naturally attaches to a diagnosis of this complication, it must be remembered that the hemorrhage is concealed, and that the patient may be thrown into a condition of danger without apparent flow of blood: her symptoms then will divide themselves into two classes—namely, those pertaining to her general condition, and those which have to do with the uterus itself; of these, the first furnishes the best indications of danger and the most rational suggestions for treatment. A rapid, weak pulse, lacking in tension; an indifferent, languid attitude of mind; respiration becoming more and more shallow; a pale or pallid face; a clammy skin; thirst; dimness of vision and "air-hunger;" a restless irritability which is a very significant symptom of a certain kind of shock,—these furnish an array of symptoms which should attract the attention of the physician.

If concealed accidental hemorrhage occurs during labor, labor-pains may cease or may grow weak, and the usual sensation of pain in the uterus may be replaced by a dull constant ache above the pubes. It is occasionally noticed that the *os uteri* is dilating without apparent labor-pains. The uterus may become enlarged, forming an asymmetrical tumor of the abdomen which can be appreciated by palpation. As regards those symptoms which can be observed on making an examination of the genital tract, the *os uteri* is usually slightly dilated, and the cervix is softened, although it may not be effaced. Slight uterine hemorrhage is generally observed. The lower uterine segment becomes distended with clot; as the hemorrhage persists the sensation conveyed to the finger resembles that in placenta prævia. Ineffectual and spasmodic uterine contractions and the accumulation of blood between the fetus and the wall of the uterus will cause irregular enlargement of the womb.

Concealed accidental hemorrhage from some other source than the uterus or the placenta may occur during pregnancy, the blood escaping into the abdominal cavity. An illustrative case is reported by Sutugin[74] of a multigravida who, three days before admission to the hospital, had fallen while carrying a heavy load. Two days after her fall she was seized with weakness, and felt no fetal movements after this time. When examined, no dilatation of the os and cervix was present. The fetal heart-sounds were absent. The patient complained greatly of pain in the uterus, probably caused by uterine contractions. Shortly after delivery the patient had clonic spasm of the extremities, and died in collapse. On post-mortem examination a large amount of clotted blood was found in the abdomen. The source of the hemorrhage was a torn vessel of the mesocolon. The uterus contained a fetus nearly at term and dead.

As regards the *diagnosis* of this condition, it must be based upon symptoms of prostration and shock greatly out of proportion to the amount of hemorrhage that may be present. The dangerous character of this complication of pregnancy and labor should lead the physician to take alarm promptly and to interfere as quickly as possible. The method of interference will depend somewhat upon whether the hemorrhage occurs during labor or before the beginning of actual labor. One of the most plainly indicated expedients in these cases is rupture of the membranes, which will lead to a closer coaptation of the uterus upon the fetal body, thus making pressure upon its blood-vessels. Accompanying this rupture, the administration of ergot or ergotin is indicated for similar reasons. Treatment by these expedients may be considered the expectant method, which, in 63 cases reported by Storer, gave a mortality of forty. Rapid dilatation of the os and cervix and delivery by version or by the forceps give a better prognosis, as in 18 forceps deliveries four deaths are reported. Where, however, the hemorrhage is sudden and severe, and the birth-canal is not sufficiently dilated to permit delivery, the uterus should be emptied, and the bleeding be controlled by abdominal incision and hysterectomy or by total extirpation of the uterus. The use of the tampon of antiseptic gauze is indicated in cases where hemorrhage externally is considerable and the os and cervix are too tightly closed to permit of rapid delivery. In introducing the tampon it is well to pack the end of the strip of gauze into the os and cervix, thus furthering dilatation and checking external hemorrhage. The *prognosis* for the fetus in these cases is exceedingly grave and is almost necessarily hopeless. Loss of blood induces rapid asphyxia, and the rapid fetal movements accompanying the partly asphyxiated state may explain some of the obstinate uterine pains from which these patients suffer.

The causal relation existing between involvement of the kidneys and intra-uterine hemorrhage has been described in treating of *Nephritis* and its consequences. In a series of clinical lectures upon the subject of hemorrhage during pregnancy Budin[75] describes the case of a patient suffering from hematuria with albuminous urine. Profuse intra-uterine hemorrhage complicated labor; the child perished.

The Posture and Bearing of the Pregnant Woman.—Accompanying the changes in the pelvis peculiar to pregnancy we find certain variations in the posture and bearing of the patient as pregnancy advances. This has been the subject of study by Kuhnow,[76] who found two types among patients in the latter months of pregnancy. The most frequent is a backward curve of the entire body, while in 20 per cent. of cases a backward bend of the trunk only was present. The cervical vertebræ are straighter, the thoracic curve is greater and more projecting, the lumbo-dorsal region is straighter, its curve being lower and flatter, while the pelvic curve is often lessened in the later months of pregnancy, and is sometimes unchanged. The hip-joints are usually carried posteriorly, while the sternum projects at its lower extremity, increasing the diameter of the thorax.

Relaxation of the Pelvic Ligaments.—Among the general changes caused by pregnancy are those affecting the joints of the pelvis. The fact that an increased secretion of synovial fluid is present in the pelvic articulation during pregnancy has long been recognized, and has been accurately studied by Driver:[77] in his examination of 300 cases he found the amount of relaxation is proportionate to the general strength and firmness of the patient's tissues. Age has nothing to do with it, nor does the amount of relaxation influence the patient's walking. Some of those whose joints were most relaxed could walk without difficulty; conversely, considerable motion produced in some patients marked lameness. Pain at a sacro-iliac joint showed that the ilium moved upon the sacrum upon that side. This phenomenon is sometimes observed in patients who are not pregnant. Some patients recovered spontaneously from a serious condition of lameness, while others were not benefited by prolonged and thorough treatment. A slight degree of relaxation may facilitate delivery and obviate the use of forceps. The most successful treatment described was an abdominal bandage of twilled cotton 5 inches wide, with padded perineal bands 1 inch wide. Where the patient was deficient in general strength cold baths and massage were sometimes useful.

The Toxemia of Pregnancy.—The interesting metabolism characteristic of pregnancy has not yet been sufficiently elucidated to explain clearly the origin of toxic material which not infrequently jeopardizes the lives of mother and child. The fact that nutrition and its converse are going on in two organisms, each dependent upon the other for proper assimilation and excretion, explains the ease with which these processes may pass the bounds of physiological activity and become disease. The character of the poisons produced in the body of the mother and the fetus places them, so far as we know, in the class of animal poisons, alkaloidal in nature, denominated toxins. The symptoms they produce upon the pregnant patient are especially addressed to the nervous system, hence the study of toxemia in pregnancy appropriately leads to a consideration of nervous disorders during this condition.

Various observers by differing methods of investigation have isolated several poisonous principles from the urine of pregnant women in whom elimination was deficient: Dührssen[78] lays great stress on the retention of creatin and creatinin in the kidneys of the pregnant patient. Actual nephritis he rarely observed, but congestion and accumulation of urine through pressure upon the ureters and by hydronephrosis are common. Creatin and creatinin accumulating in the vessels of the cerebral cortex produce cerebral irritation. It is natural that such a condition should be commonest in patients in whom excretion is habitually deficient. Poisons absorbed from the intestinal tract stand in close relation to the toxemia of pregnancy, as shown by Budin.[79] This is especially true where retroversion of the pregnant uterus produces intestinal stasis. In many of these cases the bacterium coli communis penetrates the wall of the bowel, causing peritonitis in adjacent tissues.

Culture experiments by inoculation demonstrating the toxicity of urine in pregnancy have been performed by Charpentier,[80] who, following Bouchard's researches, injected such urine into rabbits, producing tetanic convulsions and speedy death. Acute congestion in the kidneys of these animals was the only lesion found to account for the fatal issue. Similar injections beneath the skin of other animals less susceptible than rabbits produced death after longer intervals. The condition of congestion of the kidneys in patients suffering from toxemia in pregnancy is also described by Prutz.[81] He notes a very interesting point, that but slight structural alterations were present in many exceedingly severe cases of toxemic poisoning. In the kidneys of infants born from mothers suffering from toxemia there were observed congestion and transudation of serum, with the formation of casts in the tubes and great distention of the veins. A similar congestion in the livers of toxemic patients is described by Pilliet and Delansorme.[82] This condition of congestion in the kidney of the pregnant woman was found in two-thirds of the cases examined by Fischer during the second half of pregnancy.[83]

The state of the blood in these patients has been studied by Blanc,[84] who made cultures and inoculated animals with their products, producing albuminuria and suppression of urine. Convulsions were also caused, and intense congestion of the kidneys was observed. Additional testimony as to the extensive disorganization of the blood and the pathological condition of the liver in the toxemia of pregnancy is afforded by Papillon and Audain.[85] The accumulation of ptomaïns in sufficient quantities to produce poisoning has been observed by Koffer and Kundrat.[86] Paultauf and Kundrat have also reported similar cases in the *Records of the Pathological Institute of the Vienna University.*

Among many interesting contributions to the bacteriology of this question is that made by Gerdes.[87] In common with other observers, he is inclined to ascribe to bacteria a causal relation in these cases. As bearing upon this point we note the observations of Tarnier and Chambrelent,[88] who found in toxemic pregnant women that the degree of intoxication present could well be estimated by observing the toxicity of the blood-serum of these patients. It is interesting in this connection to note that any disorder caused by bacterial invasion predisposes to toxemia in pregnancy; thus, Lang[89] finds that twice as many pregnant women who are syphilitic show symptoms of threatened toxemia in pregnancy as are observed in non-syphilitic pregnant patients.

The precise toxic agent responsible for the gradual development of toxemia with threatened eclampsia has not yet been isolated, although a number of substances have been charged with this result. The significance of a diminished quantity of urea in these cases has been brought to the attention of the profession by Hermann[90] and Davis:[91] the latter in 84 cases, with a total of 564 examinations to determine the amount of urea present in the urine of pregnant and parturient women, found that the average percentage of urea in the urine of a healthy patient before labor was 1.4. After delivery this percentage increased to 1.9. Considerable diminution in this quantity was first accompanied by symptoms of irritation of the nervous system and threatened intoxication, and, where the patient's excretion was not stimulated and the amount of urea brought up to nearly normal, eclampsia developed. Davis does not ascribe to retained urea the causal *rôle* in toxemia, but he regards it as a valuable index in estimating the excretory activity of the patient.

A well-marked example of ptomaïn-intoxication during pregnancy is the case described by Gustav Braun.[92] The patient, seven months pregnant, died from pulmonary edema after premature labor. The urine contained casts and albumin. The post-mortem examination was made by Paultauf, who found fatty liver, fluid blood, nephritis, and cerebral edema. Multiple rupture of capillaries was found in the viscera. The fact that the blood of patients suffering from toxemia may contain pathogenic germs has been illustrated by Blanc,[93] who made cultures from the blood of such a patient, obtaining in forty-eight hours germs which caused albuminuria and toxemia in rabbits. It was found on experimenting that chloral in the proportion of 4 parts to 1000 of the culture-liquids effectually destroys these germs. Blanc[94] continued his experiments by injecting the urine of pregnant patients into the bodies of rabbits and observing the result. It was found that while the urine of some non-pregnant patients was poisonous when injected, the urine of pregnant patients was far more toxic, causing distinct phenomena of decided poison. Van Santvoord[95] from clinical observation ascribes toxemia during pregnancy very largely to deficient action of the liver, by which an insufficient formation of urea causes the patient to retain in her blood toxic material. The immunity which the kidneys display in some of these cases is illustrated by Prutz's description of the condition of the kidneys in 22 cases of fatal toxemia. In many of these, beyond a general congestion, no pathological condition was found. Micro-organisms were absent from the kidneys, and there was no relation between the severity of the intoxication and the condition of the kidneys. The belief that peptones are among the substances causing toxemia has led observers to study the urine of pregnant patients with regard to the presence or absence of these substances. Thomson[96] examined the urine of 23 pregnant and puerperal women for peptone; the results of his examination were negative. Koettnitz[97] made 140 analyses of the urine of 31 pregnant patients, but could not discover that peptone is a significant ingredient in these cases. It is often present in the urine of patients who suffer during pregnancy from any severe complication.

While the entire subject of the toxicity of urine offers a vast field of investigation and has produced a large literature, so far as the obstetrician is concerned there is abundant proof that no one substance is especially dangerous to his pregnant patient, but that the gradual accumulation of nitrogenous waste, of potassium combinations, and of animal alkaloids produces a condition of toxemia, the symptoms of which are first observed in a disordered state of the nervous system demanding the attention of the physician. Following the line of Bouchard, additional observation is required for a more precise determination of the relative toxicity of the various substances retained in the blood in these cases.

The prophylaxis of the toxemia of pregnancy resolves itself into maintenance of excretion. Remembering the interference with the circulation to which the patient is subjected by pressure, a first and very important precaution is to secure suitable clothing. There can be no question of the advisability of laying aside completely the corset or any other form of support for skirts that compresses the abdomen and forces the viscera down upon the brim of the pelvis. The art of dress has advanced sufficiently to enable the patient to obtain comfortable and shapely clothing supported entirely from the shoulders. Poor patients can make for themselves from cheap materials waists which fulfill the same indication. While the intelligent physician will advise and strongly urge that the corset be laid aside, he will remember that this is one of the pieces of medical advice which is expected and is rarely followed. The responsibility, however, is not his after he has stated the case fairly and clearly to his patient. Constriction of the blood-vessels should also be avoided by wearing loose shoes, by dispensing with garters that encircle the legs, and by the avoidance of constipation so far as possible. In this latter difficult problem it will be found that a proper mode of dress is of the utmost importance by avoiding pressure upon the large intestine. In avoiding constipation it is well for the patient in addition to select a diet not rich in nitrogenous elements. The heavier and less digestible meats should be omitted. Birds, lamb, mutton, fish, and oysters are best adapted for such patients. An abundance of raw fruit, or cooked fruit if the digestion requires it, is of great importance. Whole wheat, Graham, and rye bread is of value. The avoidance of large amounts of sweets and stimulants of every form is also indicated. While vegetables are useful, they are inferior to fruits for the needs of such patients. An abundance of water is a prime necessity. If the patient cannot obtain bottled waters, ordinary drinking-water which has been boiled and filtered may be taken in abundance. If her means allow her to choose, she will find the lightest Vichy or any of the slightly alkaline and effervescing waters agreeable and advantageous. Milk is to be taken freely by those with whom it agrees; many, however, cannot use it without producing obstinate constipation. The medicinal treatment of intestinal torpor threatening toxemia consists in the use of such laxatives as can be employed for a considerable time without violent purgation and without losing their effect. Compound licorice powder in small quantities, rhubarb or colocynth in combination with extract of belladonna, small quantities of the heavier mineral waters (such as Hunyadi Janos) and cascara sagrada in combination with the substances mentioned, have been found efficient. Where the liver is evidently at fault, the occasional use of calomel and soda, followed by a saline, is distinctly indicated. Where hemorrhoids complicate the patient's constipation, rectal suppositories of glycerin 1 drachm, extract of belladonna $\frac{1}{2}$ grain, and iodoform 5 grains will be found advantageous.

In addition to avoiding constipation, the prophylaxis of toxemia embraces such care of the skin as shall promote constant and free elimination. Frequent bathing in tepid water, flannel (varying in weight in accordance with the climate) worn next the skin, massage of the limbs and the upper portion of the trunk, and gentle exercise are not to be neglected. Remembering the important part which the lungs play in excretion, and the necessity for a free supply of oxygen, the patient must have an abundance of fresh air. A mild and equable climate is naturally the best for such cases, but, as this is seldom available, the patient, properly clad, should be out of doors in all weathers. It is of importance that the amount of urine secreted be observed, hence the patient should be instructed to take such precautions that this information is available for the physician. He may inform her that an amount varying within certain limits is what is expected and desired, and that any marked decrease from this should at once be reported to him. Examination of the urine of pregnant patients should be an invariable custom not to be omitted in any case. It should be done at least once a month through the entire pregnancy, or, better, once in two or three weeks. While this imposes additional labor upon the physician and inconvenience upon the patient, yet in all cases of primigravidæ, especially in women whose nutrition and excretion are not of the best, "Eternal vigilance is the price of safety." If this be reasonably explained to a patient, she will rarely object. The examination of the urine in pregnancy requires chemical and microscopic investigation. By the first we search for albumin, sugar, and urea in all cases. Important as this examination is, it is second in value to the microscopic study of the specimen. By this study we derive positive and valuable information as to the condition of the parenchyma of the kidney, and this information can be obtained in no other way. Hence in pregnancy an examination of the urine that does not include its microscopic study is certainly superficial and deficient. In cases where a suspicion exists that toxemia is developing, in addition to the substances already mentioned we must examine chemically for indican, acetone, peptone, pus, and blood. In complicated cases microscopic examination must be patient and thorough.

Diagnosis.—In diagnosticating the toxemia of pregnancy two clinical signs are of especial value: first in importance are the amount and character of the excretions; second is the condition of the nervous system. The first sign is to be ascertained by careful questioning and accurate observation. The second sign must be determined by closely interrogating the various functions of the patient's nervous system. The presence or the absence of pain, headache, thirst, lassitude, disturbances of vision, of hearing, or of taste, sleeplessness or lethargy, irritability or apathy, melancholia, and nausea and vomiting, are all symptoms to be recognized or be eliminated. The condition of the skin, as affording evidence of the functional integrity of its excretory apparatus, is of great value. Of secondary importance are the occurrence of swelling of the feet and legs and the presence of serum-albumin only in the urine.

The treatment of the toxemia of pregnancy consists in the prompt stimulation of all the eliminative organs of the body. In view of the hepatic condition present there can be no question regarding the efficiency of mercurials in a few repeated doses. The remarkable diuretic effect of calomel is also of value in these cases. In selecting saline cathartics it is best to avoid those containing potassium salts, as potassium has been shown to be an irritative element in the urine. Those purgatives producing a free flow of watery fluid from the bowel, such as colocynth, elaterium, and jalap, are especially indicated. Rectal injections of glycerin, combined with sodium salts and spirits of turpentine, are excellent in producing copious watery evacuations. The beneficial effect of such eliminative treatment on the nervous system is remarkable in many cases, the patient passing from a condition of melancholia and great restlessness to a feeling of comfort and good health. Warm and hot baths in these cases, taken before retiring, are an excellent means of treatment. If the patient's symptoms are threatening and a condition of hysteria is present, the hot pack will prove a most valuable resource. The diet in cases of toxemia should be restricted to milk, fruit, bread, and, if the patient requires more than this, fish, oysters, and gruel. Meats, eggs, vegetables, pastry, and all forms of stimulants, including tea and coffee, should absolutely be forbidden while symptoms of toxemia are present. In examining the urine two points are especially valuable: one is the amount passed daily; the second, the amount of urea excreted by the patient. If the condition of the kidney passes beyond congestion to actual nephritis, the practitioner will be aware of this through the microscopic study of the urine, when casts, bloody, epithelial, or fatty, will be present. The presence of serum-albumin and hyaline casts is of very little moment so long as a free amount of urea is excreted, and microscopic study of the urine finds no evidence that the parenchyma of the kidney is diseased.

It is evident from what has been stated regarding the toxemia of pregnancy that simple albuminuria is of little moment in the pregnant condition. The complications of pregnancy ascribed to albuminuria do not result from the presence of serum-albumin in the urine, but from the circulation through the body of the mother and her placenta of blood rendered irritating by toxic material. The occurrence of thickening and induration in the walls of the placental blood-vessels, the partial separation of a placenta in fatty degeneration following this process, with the consequent hemorrhage and asphyxia of the fetus, are familiar complications of the toxemia of pregnancy and they follow the diffusion of toxic material in the placental blood. Simple albuminuria is often seen in multigravidæ in whom, by reason of the large size of the fetus or by the relaxed condition of the uterus and the abdominal walls, the ureters are pressed upon and the kidneys are in a constant state of congestion and accumulation of urine. Many of the women thus affected have edema of the extremities, they remain entirely free from those disturbances of the nervous system seen in toxemia. The condition of such patients does not demand the production of abortion, but it requires that the heart-muscle be stimulated, the circulation be maintained in every way, and, if possible, that the pressure of the pregnant womb upon the ureters be relieved by a supporting bandage when it can be used.

In sharp distinction to these cases are those of the toxemia of pregnancy, where, notwithstanding prompt treatment addressed to the organs of elimination, the patient's nervous symptoms continue, while her excretory processes are plainly deficient. In such cases, in the present state of our knowledge, the prompt termination of pregnancy is the only rational and conservative treatment. If the toxemia of pregnancy be recognized and the patient will submit to her physician's advice, eclampsia should become more rare than puerperal septic infection.

The tendency which patients who suffer from toxemia of pregnancy exhibit to pass into nephritis after pregnancy or during a subsequent gestation must be borne in mind. In a woman who has once shown marked evidence of the toxemia of pregnancy each succeeding gestation brings added risk of fatal poisoning. If her condition be undetected and her general health after parturition be neglected, she will not infrequently become the victim of nephritis.

Disorders of the Nervous System in the Pregnant Patient.—*Neuralgia.*—The pregnant patient is peculiarly susceptible to various disorders of the nervous system. Common among these affections, and occasioning great distress, are the various forms of neuralgia often observed during gestation. As is generally the case, these neuralgias usually have as a starting-point some portion of the nervous system in which a pathological condition is present. The decay of the teeth so often seen during pregnancy accounts for many of the cases of obstinate toothache which annoy and distress these patients. In women who suffer from habitual constipation during pregnancy, and in whom the size of the fetus is so great as to cause pressure upon the nerve-trunks at the brim of the pelvis, obstinate cramp and sciatic pain may occasion great distress and may seriously depress the patient's general health. Some of the worst of these cases result from the pressure of hardened fecal matter upon nerve-trunks above the brim of the pelvis, and upon branches of nerves so situated that they may be pressed upon in the pelvic cavity. In some of these cases the uterus will be found retroverted, thus preventing proper evacuation of the bowels and adding to the pressure which retained fecal matter causes. In other patients there is great complaint of cramp and of sudden spasmodic contraction of the muscles of the thigh, often worse at night. Where the disorder is severe an obstinate pain, radiating down the thigh as far as the knee or even below the knee, is often observed.

In dealing with these cases the first duty of the obstetrician is to ascertain accurately the position of the uterus: if it be found retroverted and not bound down by adhesions, it is a comparatively simple matter to raise it to or above the brim of the pelvis, and to sustain it by tampons of carded wool. If the uterus be found bound down by adhesions, the problem is much more difficult. If the patient be put at rest in bed and the bowels be thoroughly moved by salines, a very efficient form of tampon in these cases may be found in a strip of surgeon's lint 3 or 4 inches wide thoroughly soaked with glycerin. A Sims speculum is introduced, and this strip is packed with the aid of dressing-forceps thoroughly behind the cervix, pushing the uterus up as far as possible without causing positive pain. This application is followed by a very copious discharge of watery mucus, greatly relieving congestion and softening adhesions which are not extraordinarily tenacious. The growth and development of the uterus will frequently separate such adhesions, and surprisingly good results are observed in cases where the uterus has been partially bound down in the pelvis. The fact that pregnancy exists contra-indicates, naturally, uterine massage and any instrumental interference.

If the uterus be in good position, the next step to be taken in relieving pelvic pain radiating down the thighs is to empty the bowel thoroughly: this should be done with the same care exercised in preparing a patient for an abdominal section. In addition to the purgatives usually employed, the colon should be flushed thoroughly by frequent and copious injections of warm water and sulphate of magnesia, or injections containing soapsuds and castor oil to which turpentine is added. If impaction of feces is present, an ounce of ox-gall dissolved in a quart of hot soapsuds should be injected through a rectal tube as high into the bowel as possible. This injection is to be retained so long as the patient can do so, and when an inclination to evacuate the bowels is felt a second injection of sulphate of magnesia, glycerin, and turpentine will usually result successfully. Some cases of obstinate pelvic neuralgia occurring during pregnancy are cured by emptying the bowel of hard and irritating feces.

Where the uterus is in proper position and the intestine is free from fecal matter, if pelvic neuralgia still persists, it will be found to depend upon anemia, depressing causes which affect the nervous system, or, possibly, upon malarial infection. Treatment appropriate for this condition will result in the gradual relief of the neuralgia.

Facial neuralgia with hemicrania is often observed in pregnant patients in whom no exciting cause in bad teeth can be discovered. Many attacks follow exposure to cold or to damp; others are caused by loss of sleep. The pain is often paroxysmal, and frequently an irregular interval may be observed between the attacks; thus, some patients will sleep during the night, but are seized with violent pain in the early morning; others suffer more in the afternoon or at night. The face and scalp are often tender to pressure in these cases, and the conjunctivæ on the affected side are frequently reddened.

Where painful spots can be isolated local treatment may be instituted by painting the part with menthol or with iodin, or by spraying it with ether or with some other anesthetic. The constitutional treatment of this condition consists in thoroughly emptying the intestine to relieve the patient of fecal poison which may be depressing the nervous system. Absolute rest in a darkened warm room of equable temperature, systematic feeding of easily-digested food, and tonics—iron, arsenous acid, and quinin—and, if the pain be severe, alcohol, at regular intervals are to be recommended. When sleep is impossible by reason of pain, phenacetin with caffeine and sodium bicarbonate is often used to advantage. If pelvic neuralgia be present, phenacetin may be given by rectal suppositories of 10 grains each. Morphia and atropia may be given hypodermatically when other remedies fail. Chloral and the bromids are of comparatively little value and often disappoint in these cases. It should be explained to the patient that the less opium she takes the sooner she will recover; and where her suffering is not severe every effort should be made to improve her general condition by tonic treatment rather than by narcotizing her with opium.

Salivation.—Derangement of various secretory nerves is sometimes observed during gestation; the salivation of pregnancy is a familiar instance. Hypersecretion of tears is seen in patients suffering from salivation, as shown in a case reported by Neiden.[98] So abundant was the secretion as to keep the eyes continually suffused and to cause an eczematous eruption of the lids. The tear secretion was weakly alkaline, the eyes were normal, and no appreciable cause was found for the condition present. The patient was finally cured by a 5 per cent. cocain solution. Salivation of pregnancy is a most obstinate and annoying condition often repeated in subsequent pregnancies and resisting all forms of treatment. It is without apparent cause, as a rule usually affecting women of nervous temperament, especially if the general health be depressed. Treatment is usually palliative only, and it should consist in the free administration of tonics and in those milder sedatives which interrupt least of all the patient's nutrition. The bromids have been given freely, both by the stomach and by spray applied to the interior of the mouth. Cocain may also be sprayed into the mouth, the effort being to cocainize the mucous membrane near the opening of Steno's duct. This condition rarely if ever becomes serious. Another form of abnormal secretion occurring in pregnancy is that of excessive perspiration, which is commonly met with in poorly-nourished and neurasthenic cases.

Herpes is found among the interesting disorders of the nervous system to which the pregnant patient is liable. Fournier[99] reports a case in which the lesions were distributed irregularly over the body, especially upon the forearms, the anterior part of the thorax and feet, and the abdomen. Accompanying these lesions were patches of redness, in some instances these areas being covered with bullæ as large as an olive or a small cherry. The usual period of pregnancy at which this disorder occurs is between the third and the fifth month, occasionally as late as the sixth or the eighth month. In other cases, more rare, the lesion does not show itself until the second or the third day of the puerperal period. There is a strong tendency in this disorder to recur during subsequent pregnancies, and instances are given where the patient has suffered from herpes during five successive gestations. Although intolerable itching and burning accompany herpes during pregnancy, yet the general health remains remarkably unaffected. The occurrence of gestation is not influenced by this complication, and patients usually recover promptly when gestation terminates. Herpes in the puerperal period is often characterized during its onset by fever, perspiration, and general pruritus. In from twenty to twenty-four hours after these symptoms occur the characteristic eruption appears. The remarkable tendency of herpes to recur is illustrated by the cases of Cottle, Wilson, Gale, and Hardy, the last of whom describes a patient who suffered in nine out of ten pregnancies with this disorder.

There is no evidence that the fetus and its appendages are affected in this disease. Occasionally mixed forms of the eruption are seen, some of them resembling pemphigus and others assuming a syphiloid type. It is noticed that young women are oftener attacked by herpes than those older.

The treatment of herpes consists, first, in properly regulating the functions of the body. Herpetic patients are generally depressed or in some manner are deficient in nervous energy, and they will be found to improve under the prolonged use of arsenic, hypophosphites, and iron. The great number of remedies which have been administered as specifics in this disorder, and their failure to influence the course of the disease, show that it is not amenable to specific treatment. When the eruption first begins borated vaselin, glycerol of starch, and lime-water and oil will be found soothing applications. When the eruption is fully developed bismuth and starch and starch-and-talcum powder are useful dressings. For the intolerable itching, applications of carbolic acid, hydrate of chloral, menthol, or corrosive sublimate in solution have been found useful. When a large portion of the body is involved, baths containing starch, gelatin, or bran may be employed.

While the prognosis of herpes complicating gestation is favorable so far as the continuance of pregnancy is concerned, still this complication exercises a most depressing influence, and may lead to complicated labor by reason of exhaustion. Care should be taken, then, to support the general strength of the patient in every possible way, to promote her nutrition by a carefully-ordered diet and the persistent use of tonics, and to see to it that during labor her strength is conserved in every possible manner.

Sudden death during pregnancy may result from the entrance of fluid or of air into the enlarged sinuses of the uterus. Hektoen[100] narrates the case of a patient who, while taking a vaginal injection, fell dead: it was found that she had been using a Davidson syringe. The autopsy showed the tissues of the uterus filled with air and blood and the placenta partially detached, while the right ventricle contained frothy blood, but no clot. Air was found in the subserous vessels and also in the vessels of the pericardial and pleural cavities.

The condition of pregnancy seems to predispose to sudden heart and respiratory failure. This is especially the case where nausea and vomiting have been well marked during the first months of pregnancy. McCabe[101] reports the case of a patient who desired relief from obstinate nausea and vomiting, and to whom morphia had been given by hypodermatic injection. As it was impossible for the attending physician to see her at short intervals, a hypodermatic injection was prepared by him and left for administration during his absence. She seemed relieved, but a few days after, on attempting to move, a sudden weakness developed, terminating almost immediately in death.

The same observer describes the case of a young woman who during her second pregnancy was much annoyed by intense pain over the uterus and across the lower part of the back, simulating after-pains. A hypodermatic injection of $\frac{1}{4}$ grain of morphia was given, which made the patient easy. It was found that she had miscarried the night previous at about two and a half months of gestation. There was no sign of puerperal septic infection, but a rapid and weak heart caused the patient much distress. During the night following she suddenly sprang from her bed, and almost immediately expired.

As in both the above cases morphia had been given by hypodermatic injection, the relation borne by this drug to the phenomena observed is of interest. It would seem from these cases that morphia hypodermatically is a dangerous drug to be administered to pregnant patients.

Cerebral thrombosis and hemorrhage during pregnancy are illustrated in a case reported by Horrocks,[102] in which a patient in her second pregnancy developed stupor and drowsiness with rectal and vesical incontinence during the last month of gestation. The pupils were equal and symptoms of palsy were wanting. The urine contained neither albumin nor sugar. The heart seemed normal, and labor subsequently came on spontaneosly. Consciousness, however, was obscured, and derangement in the motor apparatus of the brain and nervous system was evidently present. After death many of the cerebral veins were found occluded by thrombi. There was also recent extravasation of blood along the internal capsule. Cystitis and suppurative nephritis on one side existed.

Meningitis during pregnancy is almost invariably fatal to the mother, and frequently to her child. Chambrelent[103] describes 7 cases of acute meningitis during pregnancy, in six of which labor was terminated artificially with the birth of a living child. In one case birth was spontaneous before the mother's death. In view of the grave nature of this complication labor should be induced in cases of meningitis during pregnancy where the fetus is viable, in the hope of saving the life of the infant.

Spinal Irritation complicating Pregnancy and Labor.—The hyperemic and hyperesthetic condition characterizing pregnancy exaggerates all forms of functional nervous disturbances or pathological conditions in the nervous system. Spinal irritation is not infrequently observed, and it is well illustrated by cases reported by Napier.[104] The symptoms were great tenderness on pressure along the spines of the vertebræ, and in one patient fatal albuminuria gradually developed. These cases followed an epidemic of diphtheria which prevailed four or five years prior to these observations: the poison of diphtheria seemed to lose its activity by attenuation. Cases of cerebro-spinal meningitis developed as the epidemic died away, and last of all occurred the cases of pregnancy complicated by great tenderness along the spine, which tenderness seriously impaired the patients' strength and hindered convalescence. A toxic condition following widespread diffusion of diphtheritic poison should be considered as the cause of these cases, but the phenomena of spinal irritation were predominant.

Maternal impressions are familiar to all obstetricians of extensive reading and experience. It is not the writer's purpose to consider the matter in detail, but simply to draw attention to the fact that a pregnant patient may undoubtedly so profoundly be influenced by nervous shock as very markedly to alter the development, the shape, the size, and the appearance of her offspring. In recent literature on the subject Mackay[105] describes five cases in which fright produced distinct birth-marks upon the fetus. The writer may add a case under his personal observation in which a pregnant woman was informed that an intimate friend had been suddenly killed by being thrown from his horse: the immediate cause of death was fracture of the skull, produced by the corner of a dray against which the rider was thrown. The mother was profoundly impressed by the circumstance, which was minutely described to her by an eye-witness. Her child at birth presented a red and sensitive area upon the scalp exactly corresponding in location with the situation of the fatal injury in the rider. The child is now an adult woman, and this area upon the scalp remains red and sensitive to pressure, and is almost devoid of hair.

Space need not be taken to discuss the question of maternal impressions. There is certainly more than coincidence in the fact of fright and shock and the subsequent malformation or marking of the fetus. The well-known "elephant-man" of England, and the "turtle-man" exhibited in the United States, with other instances, are familiar evidences of this statement.

Chorea during Pregnancy.—There is no disorder of the nervous system so manifestly aggravated by pregnancy as chorea. The physiological plethora characteristic of normal pregnancy seems to exaggerate the functional activity of the nervous system, and it results in marked exacerbation of all pathological phenomena. The characteristic choreic movements occasionally extend even to the uterus, as in a case reported by Braxton Hicks.[106] The patient was a young woman who had suffered from chorea in childhood: the uterus, which could be outlined distinctly in the abdomen, presented marked alterations of form, accompanied by very evident choreic contractions. These uterine movements became less violent as the patient was treated by rest in bed and by the administration of arsenic: she was subsequently delivered in normal labor, making a good recovery.

In an elaborate essay upon the subject McCann[107] divides cases of chorea occurring in pregnant patients into cases of true chorea, of hysterical chorea, and a mixed form. It is rare to find chorea occurring in patients after the eighteenth year, except during pregnancy. Primigravidæ are more susceptible to chorea than are multigravidæ, especially to true chorea. In patients free from rheumatism it is rare for true chorea to occur in any but the first pregnancy. When the exaggerated reflex condition which occurs in chorea is called to mind, it is natural to expect that the great majority of cases will occur in the third and fourth months of gestation. The reason for this occurrence seems to be the irritating effect upon the nervous system of fetal movements which begin to be felt at about that time. So far as the etiology of chorea in pregnancy is concerned, acute rheumatism is the most immediate cause, and next comes an hereditary history of distinct rheumatic taint. Epilepsy and other disorders of the nervous system predispose to chorea during pregnancy. Fright, emotion, and profound anemia also favor its occurrence. For the actual outbreak of chorea, however, there must be present an hysterical predisposition to nervous excitability, a depreciated condition of the blood, and an actively exciting cause, which is usually found in fetal movements. Post-mortem examinations of patients who have died from chorea during pregnancy show that in severe cases the motor cortex, the intellectual centres, and the spinal cord are all involved. In mild cases the motor cortex only is implicated, and the spinal cord least often.

The effect which chorea produces upon pregnancy depends entirely upon its severity. In mild cases amenable to treatment the pregnancy is not interrupted; while in severe cases abortion occurs, sometimes followed by fatal termination from coma and high temperature. Severe cases of chorea which do not result fatally may end in mania persisting for a considerable time. Paralysis and delirium are also occasionally observed to follow this disorder. If the pregnancy is at term when the mother is attacked by chorea, the risk to the child is but very little, if any, increased. The earlier in pregnancy that chorea occurs, the greater is the danger to the existence of the fetus. Although the physician naturally hopes that choreic movements will cease after delivery, such is rarely the case; they die away very gradually, and they have been observed to continue for five months after labor. Pregnancy predisposes greatly to the recurrence of chorea, so that a girl who has been choreic in early life will almost surely again become choreic should pregnancy occur. As in the non-pregnant, chorea during pregnancy is sometimes more severe than a former attack, and, again, may be less violent. Chorea during childhood is very apt to reappear in subsequent pregnancies in the same individual. It is also interesting to note that the younger the patient, the greater is her liability to a recurrence of chorea.

The great liability of pregnant patients to hysterical manifestations results to a very perplexing degree in introducing this element into cases of chorea during pregnancy. The differential diagnosis is best made from the character of the movements, which in hysteria are more sudden and occasionally are rhythmical in character. Impairment of sensibility is noted as a prominent symptom in cases possessing a strong hysterical element. A history of previous hysteria is sometimes obtainable. In making a differential diagnosis imitation movements must be borne in mind, as they are sometimes calculated to deceive skilled observers. As regards the portion of the body most often affected by choreic movements, Gowers[108] out of 64 cases found eleven in which the right side only was affected, and thirteen in which the left side alone was affected. During pregnancy chorea is most often bilateral, the reason for this being that as the disease is more severe than in the non-pregnant, its manifestations are more widespread. It is usually found in these cases that in the beginning the movements were unilateral, afterward becoming bilateral as the disorder increased in severity. The physiognomy of the pregnant patient suffering from chorea is characteristic, being listless and vacant in expression, and when the facial muscles are affected peculiar grimaces resulting. General relaxation of the muscular system often occurs early in the disease, and in the later stages mental apathy is not infrequent. Dilated pupils are often present, and are thought to depend upon a generally relaxed condition of the muscular system. In a large number of cases the face is affected; in a few, however, it is not. Speech and the movements of the tongue become involved in the severe cases. Sighing and irregular respiration have been described by Romberg and others. It is interesting to note that chorea more severely involves the memory of pregnant patients than of non-pregnant. The cessation of choreic movements is promptly followed by improvement in memory. Patients who become maniacal after chorea often give utterance to a peculiar cry described by Romberg and others. The analogy between the cry of chorea and that of the patient about to be seized by an epileptic paroxysm is interesting. The prognosis of mania or delusions complicating chorea in pregnancy is often unfavorable; should the patient not have chorea after her delivery, she may be found the victim of delusions or of chronic mental apathy.

Symptoms of chorea especially referable to the pregnant state are, first in importance, those produced by the quickening of the fetus. The presence of a nervous temperament in a choreic patient, or its absence, will determine the severity of the symptoms. As regards the influence of chorea upon labor, choreic movements often cease when labor-pains set in; such movements generally die away during the stage of uterine contraction, often to recur so soon as the labor-pain is over. The labors themselves are often normal, and in many cases during the pains, especially when the patient endeavors to assist them, the choreic movements become more than usually pronounced. While there is a temporary lull in the choreic movements after the birth of the child, the effort to expel the placenta is usually followed by their exacerbation. It occasionally happens that choreic movements become more than usually increased during the puerperal state about the third or the fourth day. The irritation incident to the formation of milk has been cited to explain this fact. Abdominal pain, which often accompanies movements of the bowels at this time, is also thought to cause increased choreic movements. Pressure on the uterus and the abdomen sometimes increases choreic movements during the puerperal state. The irritation of nursing their children has aggravated chorea in some patients, the convulsions becoming so violent that the nipple was jerked out of the child's mouth.

In choreic cases endocarditis is sometimes observed as a complication, and it makes the prognosis much more serious. Hemic murmurs dependent upon anemia are exceedingly common in these patients. An examination of the urine shows an excess of urea and phosphates, probably the result of the increased muscular activity of the convulsive seizures. In diagnosis the chief difficulty arises in distinguishing the true chorea of pregnancy from the hysterical and mixed forms. Attention may again be called to the fact that in true chorea movements are irregular and spasmodic, and are increased by motion and voluntary effort, especially if such effort be sustained. In the hysterical form movements are sudden, isolated, and often rhythmical, especially in the fingers. Hysterical chorea never becomes so intense as greatly to exhaust the patient. Delirium, acute mania, and delusions may complicate chorea during pregnancy, as illustrated in the cases described by Jones;[109] one of his cases was complicated by septic infection following premature birth of a decomposed fetus at seven months. In another case paralysis of the left arm occurred as a complication. Children born of choreic mothers sometimes show marked tendency to convulsive movements. Bué[110] describes two cases in which the chorea of the mother reappeared in convulsive movements of the child. Maniacal chorea is to be distinguished from the mania of pregnancy and the puerperal state by a previous history of choreiform movements. In default of such history an exact diagnosis is often difficult. In maniacal chorea the patients are less sullen and are more garrulous than in true mania. In estimating the dangers of chorea in pregnancy the violence of choreic movements, the amount of sleep lost in consequence, and the intercurrent complications must all be considered. The prognosis of maniacal chorea is usually good as regards the mental condition. Occasionally mental defect persists for a long time after labor, and it may ultimately become permanent. Septicemia and pyemia very seriously complicate such cases.

So far as *treatment* is concerned, sedatives and narcotics have been used extensively with but indifferent success. The indications for treatment are to secure bodily and mental rest, to procure sleep, and to bring about an improved condition of the patient's blood and nutrition. It is often necessary to protect the patient's skin from friction caused by the severity of the movements. A profoundly depressed mind and nervous system call for an entire change of surroundings. In the medication of these cases arsenic, intelligent feeding, and the maintenance of proper digestion are of the greatest importance. Rest in bed, freedom from annoyance and excitement, bathing, and gentle friction are also of value. To procure sleep, chloral in doses of 30 to 40 grains has given good results. Gairdner[111] relates the case of a girl, eight years of age, who took by mistake 60 instead of 20 grains of chloral to procure sleep; she recovered from the drug, and was permanently cured of her chorea by the dose she had taken. Trousseau and Gowers have used in these cases strychnia, pushed to a physiological effect. Sodium salicylate, wet packing, and the application of cold to the spine have also been recommended. So far as the obstetric treatment of these cases goes, the obstetrician must guard against hemorrhage, to which the anemia so generally present predisposes. Violent choreic movements also render it difficult to control the uterus during the third stage of labor. The debilitated condition of the patients exposes them to additional risk of septic infection. When chorea persists after delivery nursing should be prohibited, as it undoubtedly tends to aggravate the condition. If the chorea be slight or of the hysterical form, the pregnancy should not be interrupted. In all severe cases, however, labor should be induced. The following conditions may be cited as calling decidedly for the interruption of pregnancy in a choreic pregnant patient: threatened exhaustion on the part of the mother from the intensity of the movements and a deficiency of sleep; when mania or fixed and dangerous delusions are present; when a grave physical complication, such as endocarditis, increases the gravity of the case.

Pantzer[112] reports the case of a woman, aged twenty-six years, pregnant for the fifth time and suffering severely from chorea. In a previous pregnancy her movements had been so excessive that labor was induced, after which choreic movements persisted for several weeks. During the pregnancy in question she was obliged to enter a hospital. Although easily excited, she was readily controlled by morphia, and no grave condition was found at confinement threatening the interest of her child or herself. The usual treatment for chorea was administered, with the added precaution of avoiding large doses of bromid, which tend to favor hemorrhage after labor. The patient's labor was normal, and she made a good recovery.

Catalepsy is occasionally observed during the pregnant state, as in a case recently reported by Shoot of Lunwarden.[113] The patient was a robust woman, aged forty-four, who had borne eleven children; in youth she had suffered from typhus, and after recovery became subject to fainting fits, but throughout her married life she remained strong and well. There was no history of a neurosis in her family. During the seventh month of her twelfth pregnancy she was seized with cataleptic fits following the loss of a child: she was found stiff and motionless by the attending physician. The forearm could be raised and bent with some force, and remained in the same position for about ten minutes, after which it slowly fell. The lower extremities behaved in a similar manner. Consciousness was lost. The pulse was 64, full and regular, the temperature and respiration normal. The pupils were somewhat dilated, but reacted to light. On inhaling chloroform the rigidity of the muscles disappeared, and the patient seemed to sleep calmly for hours. On awakening the patient remembered nothing that had taken place. The fetal heart-sounds, previously audible, were lost, and were not heard until fourteen days before labor. No albumin was found in the urine upon examination. Cataleptic fits occurred three or four times daily, occasionally with an interval of several days. Atropin gave the patient a week's freedom; the disorder continued, however, to term, when she was safely delivered of an apparently healthy boy. On the fifth day after labor an attack recurred while the patient was nursing her child; two days later the second took place, which was the last. Shortly after the first attack her child, who had been weaned because of the cataleptic complication, was seized with dysphagia. In the evening of the same day the child had a cataleptic fit, the symptoms being precisely those of the mother. The rigidity which developed relaxed during a warm bath, but soon afterward returned. Tonic cataleptic convulsions recurred, and the child died after two days' duration of the cataleptic fits.

Pregnant patients are exposed to those poisonings of the nervous system from lead, arsenic, dyestuffs, tobacco, and other substances met with in the arts, and which commonly act by producing, among other complications, multiple neuritis. In the absence of specific poisons multiple neuritis is occasionally observed, as described by Solowieff.[114] His patient was three months advanced in pregnancy and suffering from nausea and vomiting. No cause for the latter complication could be found in the condition of the urine or of the genital tract. Her nervous symptoms, however, were peculiar and pointed to multiple neuritis, especially well marked in the lower extremities and upon the back and neck. The organs of the special senses were in a very hyperesthetic condition; the blood was normal. Her history included an attack of scarlatina in childhood, and also hysteria. She was nourished, when necessary, by rectal injections, and was treated by faradization and hypnotism. A very careful study of her nervous system showed polyneuritis in very widespread degree. A post-mortem examination showed all the viscera free from marked pathological change. The nerve-trunks, however, throughout the body gave evidence of varying degrees of degeneration; this was especially true of the phrenic nerves: it had been noticed during life that the action of the patient's diaphragm was at times very deficient.

Diabetes.—Among the rare disorders of pregnancy in which the nervous system and the assimilation of the patient seem equally affected may be considered diabetes. Its rarity may be inferred from the statement of Griesinger, who found, of 53 cases among women, two only during pregnaney. In Frerichs' large experience, in 386 cases there were 104 among women, and only one of these had diabetes during pregnancy. Matthews Dunean[115] reports the case of a multigravida who had a suspicion of diabetes for a short time in a former pregnancy. At the eighth month her fetus perished *in utero*. Excessive amniotic liquid was present. The patient collapsed before labor began, and perished shortly after. During her first pregnancy she had suffered from great thirst, and passed enormous quantities of urine during the first few days after delivery. During the pregnancy which ended fatally her urine was examined two months before her eonfinement, and nothing abnormal was deteeted. It was excessive in quantity. The patient's tongue was dry and brown, her breath had a peculiar swcetish odor, and purplish areas were detected upon the skin. Her temperature was normal, but she suffered greatly from a sensation of oppression. Reid reports a case very similar to Duncan's. The amniotic liquid was very abundant, and it possessed an abnormally great amount of albumin. The child was large and well developed, but dead before labor. Newman saw diabetes in two pregnaneies in the same patient, the mother finally perishing of the disease. Lecorchi observed diabetes in an infant born of a diabetic mother. Williams reports a case, with autopsy, in which the liver and kidneys were found granular and in pale cloudy swelling. In Husband's case the liquor amnii was saccharine. Bennewitz and Winckel also report cases. In Duncan's case an examination of the eyes revealed a large pear-shaped clot in the central spot of the retina. The patient was suddenly taken with intense pain in the right side of the abdomen in the fifth month of pregnancy. Labor was induced, but the child was dead and decomposed. The patient died, and no cause for the fatal issue could be found on post-mortem examination. Frerichs discovered in a patient, in the eighth month of pregnancy, who suffered from diabetes and who perished after delivery, a tumor of the medulla oblongata. Diabetes may occur during pregnancy only, being absent at other times. It may eease with the termination of pregnancy and may recur afterward. The prognosis for subsequent pregnancies is not invariably bad, as a patient, if cured of diabetes, may in subsequent pregnaney escape its return. The existence of diabetes does not militate against conception.

A possible explanation of the occurrence of diabetes during pregnaney is found in the results of the study made by Oddi and Vicarelli:[116] these observers found that during pregnancy there is a largely increased consumption of hydrocarbons derived from the waste of nitrogenous material resulting from fetal nutrition and growth. This was seen by analyzing the air respired by pregnant patients. It is rational to conclude that cases in which this metabolism is seriously disturbed may furnish the complication of diabetes during pregnancy.

Diabetes seems almost uniformly fatal to the fetus, and that at a comparatively early period of gestation. The amnion seems to be the seat of the diabetic process, and dropsy of the amnion or the formation of saccharine matter in the amniotic liquid is the condition most commonly observed. Fry[117] reports the case of a patient in her second pregnancy who suffered from great thirst and who was easily fatigued. Examination of the urine showed 9 per cent. of sugar, which was reduced by treatment to 5 per cent. The child perished during pregnancy. The mother died five days after delivery.

The treatment of diabetes complicating pregnancy is that which the practice of medicine enjoins in such cases. The fact that the life of the fetus is usually lost should lead the obstetrician to disregard it, and to empty the uterus promptly if the diabetic condition is pronounced. The *prognosis* for the mother, should she survive labor or abortion, is unfavorable, as the diabetic condition commonly persists and ultimately proves fatal. The fact that diabetes occurs in pregnancy, and that it is attended with peculiar fatality, emphasizes the necessity for the examination of the urine in pregnant patients. The presence of more than a trace of sugar should lead to a thorough examination of the patient's processes of assimilation, when it may be possible to avert further development of diabetes, and thus save the lives of mother and child.

The pathology of diabetes mellitus complicating pregnancy is well illustrated by a case reported by Hehir.[118] The patient, a multigravida, suffered from diabetes during pregnancy, and gave birth to a dead fetus nearly at term. Amniotic liquid was turbid, having a heavy, mawkish odor, and being very abundant. An infusion was made from the epidermis of the fetus, and traces of sugar found in this infusion. The liquor amnii was also examined, and in it sugar was found. The patient had been greatly annoyed during her pregnancy by excessive corpulence, and had suffered from polyuria and diabetes mellitus. Hehir also describes a case of diabetes in pregnancy in which abortion occurred at the fifth month; similar phenomena were observed in this case.

Idiopathic universal pruritus as a complication of pregnancy may occasion great distress and may seriously interfere with a patient's rest and nutrition. In two cases reported by Feinberg[119] the disorder became worst at the time when menstruation would have occurred had pregnancy not been present. Palliative treatment mitigated the patient's sufferings to some extent, but it was unsuccessful in relieving the disorder. Both patients were exceedingly nervous, easily excited, and one of them aborted under great excitement.

Pruritus limited to the vulva and vagina is frequently observed as a complication in patients suffering from diabetes during pregnancy. In such cases any form of *treatment* which lessens the amount of sugar in the urine decreases the patient's suffering from pruritus. In cases not associated with diabetes local applications are indicated, such as antiseptics, in strong solution, painted over the part. Thus, bichlorid of mercury (1 : 1000) followed by an application of salt-solution or plain water, carbolic acid, 3 to 5 per cent., tincture of iodin, glycerin, and carbolic acid, are often employed. In patients not unduly susceptible cocain is used to advantage, although the extensive area to which the application must be made renders it a dangerous one to patients readily influenced by the drug. The application of electricity by placing a moist electrode upon the mucous membrane of the vulva has been beneficial in some cases. The observance of cleanliness is of great importance, especially where a vaginal discharge annoys the pregnant patient. Douches of carbolic-acid solution, of creolin and green soap, of boracic acid, of alum in solution, or of a hot solution of sodium bicarbonate should be tried faithfully. Sitz-baths of a warm solution of boracic acid, of sodium bicarbonate, or bran sitz-baths are also indicated. The local application of starch and laudanum or lead-water and laudanum is another resource of service. Where extensive irritation and excoriation are present the application of an ointment containing belladonna, opium, and iodoform is often a source of great comfort. Pencilling the mucous membrane with nitrate of silver is occasionally of value. In the majority of cases, however, the best treatment for pruritus of the vulva and the vagina complicating pregnancy is to be found in careful cleansing, effected by gentle irrigation of the parts with non-irritating, antiseptic fluids, and by constitutional treatment addressed to improving the condition of the patient's nervous system and assimilation.

Hysteria during pregnancy furnishes an interesting illustration of the fact that the pregnant condition exaggerates any previous defect or susceptible point in the patient's mental and physical organization. The belief once entertained that pregnancy exercises a favorable influence upon women already hysterical is certainly erroneous. It occasionally happens that a pregnancy, greatly desired and occurring amid the most favorable circumstances, furnishes a healthy stimulus and assists a patient in cultivating self-control, but such cases are the exception and not the rule. Mild forms of hysteria during pregnancy often take the shape of melancholia and fear of approaching confinement. Such cases require patient encouragement on the part of friends and physician, and should stimulate the obstetrician to take every precaution that he be surprised by no unforeseen complication during the labor. If the physician makes a thorough study of his patient before labor, and demonstrates to her that he has exercised every precaution in her behalf, it will go far in allaying her apprehensions. In the experience of the writer preliminary examination of pregnant patients by palpation, auscultation, and pelvimetry often exercises a very favorable influence in such cases. Hysteria complicating pregnancy becomes dangerous when it passes into a condition of maniacal excitement. While the prognosis in such cases is not unfavorable so far as the recovery of the mother goes, yet these patients require prolonged and careful treatment, and should labor occur during mania injury to the fetus or to the mother may result. Such cases require constant watchfulness, kind and systematic restraint, and when any obstetric manipulation is required the use of anesthetics is usually a necessity. As one of the dangers that threaten in these cases is exhaustion through a refusal to take food, feeding of such patients is a cardinal point in their treatment. As is so often seen in dealing with the insane, it is better to attempt no deceit in their management, but to win the patient's confidence by faithful and patient attention without dissimulation.

Mania complicating pregnancy is of importance chiefly as influencing the course of labor and the puerperal state. Mania is observed during pregnancy in patients of very neurotic organization, in those having a heredity of insanity, in women who have been alcoholic, hysterical, or in other ways neurotic, and in women who suffer some great mental shock while in the pregnant condition. Unhappy marriages form a considerable element in the causation of mania during pregnancy. The diagnosis in these cases is to be made by eliminating hysteria, delirium tremens, hystero-epilepsy, and the temporary delusions and hallucinations which sometimes accompany toxemia from deficient excretion. In the former, observation will usually make differential diagnosis a matter of ready accomplishment. In cases of toxemia a study of the patient's excretions is required to arrive at a correct result. The prognosis in these cases depends upon the underlying condition which is the exciting cause of the mania. In those of highly neurotic organization, but whose physical condition is good, the prognosis for life is good, but the outlook for mental soundness is not brilliant. In cases where mania has followed a profound shock, as by sudden bereavement, an accident, or a calamity, if the patient's physical condition is good the prognosis for a complete recovery is also good; this is especially true if the child is carried to term and survives its birth. If, however, mania is grafted upon a background of serious physical disability where some well-marked pathological condition is present, it may be the forerunner of a fatal issue—if not at labor, within a short time afterward. This is especially true in those cases where toxemia and interstitial nephritis are beginning, and where the patient, if she escapes eclampsia, passes into a condition of pronounced and fatal nephritis after labor.

The treatment of mania during pregnancy varies with the condition which excites the mania. What has been said regarding the treatment of hysterical mania applies to cases where the patient is neurotic, but is physically in good condition. In women who become maniacal in the presence of calamities or of sudden bereavement the free use of narcotics for a time is often indicated to secure sleep. If the life of the child continues, the hope of its birth and maternal affection should be used as powerful mental tonics in dealing with the mother. Perfect seclusion and protection from all intrusion are absolutely essential. When the first shock to the mind and the nervous system has passed, all the resources of the therapeutic art are required in promoting the nutrition of the brain and nervous system. The treatment of mania complicated by toxemia through deficient excretion calls for the avoidance of narcotics and sedatives and the prompt securing of active elimination. As soon as the patient is freed from the poisons which are irritating the brain her condition usually is markedly improved.

Nausea and Vomiting of Pregnancy.—On the border-line between the physiology and the pathology of pregnancy, nausea and vomiting have been considered by some as an inevitable result from the irritation occasioned by the development of the pregnant uterus, and by others as purely a pathological phenomenon. Like the kidney of pregnancy, the pregnant uterus and its nervous supply are in a condition of plethora which borders upon an actual pathological change. The progress of our knowledge in the pathology of pregnancy gives good reason at present for the belief that nausea and vomiting are not a physiological, but a pathological, accompaniment of the pregnant condition. As many patients pass through pregnancy with no pathological lesion of the kidneys, so many women bear children without the nervous irritation and the anemia, slight or profound, that accompany nausea and vomiting.

The predisposing causes for the emesis of pregnancy are to be found in a congenital irritability of the nervous system, that produces exaggerated response to normal reflex stimuli. The predisposing causes for this affection are anatomical lesions in the generative tract, notably congenital malformation of the uterus or dislocation of the pregnant womb. The exciting causes for this complication are sudden shocks to the nervous system that powerfully exaggerate its reflex susceptibility. An infective process producing hyperemia and irritability of the cerebro-spinal axis may also be an exciting cause for the nausea and vomiting of pregnancy. A pathological process which affects the constitution of the blood is also a frequent exciting cause in these cases. Direct mechanical injury or violence to the pregnant womb often begins and maintains this condition; thus, a patient in early pregnancy, while straining or lifting, suddenly retroverts the uterus, and obstinate emesis follows. Metallic and irritant poisons absorbed into the system, vitiating the blood and irritating the nervous centres, produce nausea and vomiting. Among the most frequent of the exciting causes are the movements of the fetus *in utero* and excessive peristalsis in the mother's intestine. Distention of the bladder and the rectum is frequently present in these cases.

The diagnosis of this condition must usually be made in large part from the statements of the patient or from those of her attendant. As such vomiting is most frequent in early morning, unless in severe cases the physician rarely has an opportunity actually to observe the phenomenon. In mild cases nausea begins as soon as the patient raises her head from the pillow. The desire is for instant emesis, which is usually accomplished without straining, and is often repeated. Following this emesis the patient may take food with appetite, and the phenomenon may not recur until the next morning. In such cases the matter vomited is mucus, sometimes of strongly acid reaction, sometimes of neutral reaction. In more severe cases the sensation of nausea begins as soon as the patient awakes; assuming the upright posture is followed by vomiting but little relieved by emesis. The material ejected is mucus, often burning and bitter to the taste, frequently excessively sour. Although the patient may succeed in retaining food, the sensation of nausea persists often until mid-day or even later: the sight or the presence of certain articles of food greatly increases her distress. Perturbation of any kind exaggerates the sensation of nausea. If vomiting is repeated, it is accompanied by straining and retching. After mid-day the patient is better, and may eat heartily at evening. Such cases are accompanied by anemia and often by considerable loss of weight. A third class of cases is well characterized by the term *per-*

nicious; in them the sensation of nausea is present at intervals during the patient's waking hours. Her cravings are for varied articles of food and drink, and they are no sooner satisfied than a new craving arises. Vomiting is accompanied by straining and retching, by dryness of the fauces, or by profuse salivation. The matter ejected is, first, mucus and the food taken, bile, and, in severe cases, mucus stained with blood or with coffee-ground material. Food is no sooner swallowed than it is ejected, although there occur surprising periods of tolerance in which the patient eats greedily, and which occasion hope in the mind of the physician that substantial improvement has taken place. As the case proceeds distress and pain are felt beneath the sternum, not located at any fixed point. The sensation is described sometimes as that of smothering, but more often as that of distress which has nothing to do with breathing. In dangerous cases it is worst at night. Emaciation is progressive—in some cases rapid, in other cases slow. A more deceptive phenomenon in these patients is acute fatty degeneration of the tissues, that gives to the patient a plump appearance which may deceive the physician. As the case progresses the clinical picture of pernicious anemia becomes more and more apparent. Signs are present of disintegration of the blood in the vomit, in hematogenic jaundice, in sordes, and in purpuric extravasations. The urine contains the *débris* of broken-down corpuscles, the feces are dark in color, the mucous membranes dark and reddish in appearance, and the mental condition is one of apathy or of delusion so often seen in these cases. A further explanation of the process is observed in the condition of the eyes by a necrosis of the cornea, and dimness of vision may be noted. The pulse and the cardiac action of the patient in severe cases of nausea and vomiting of pregnancy show the effect upon the heart and the arteries of the gradually developing anemia. The pulse is rapid, soft, and weak. Arterial tension is usually diminished, the first sound of the heart grows less and less distinct and forcible, and in fatal cases cardiac syncope develops. The temperature is subnormal at first; later in severe cases it increases as a fatal issue approaches. In other cases the temperature varies slightly from the normal, and in all cases it is not an important factor in diagnosis or in prognosis. The pulmonary signs are usually negative: the patient occasionally complains of an irritable cough which accompanies a dry condition of the fauces, or in others of the accumulation of an excessive amount of mucus. Palpation of the abdomen may detect a dislocation of the uterus, and in the early stages of the more severe cases the abdominal walls are often excessively irritable, the practice of palpation increasing the nausea. Liver-dulness is usually slightly increased in area as the liver becomes the seat of acute parenchymatous, fatty degeneration. The patient's reflexes are much increased, although paralysis or atrophy, other than that attending emaciation, is seldom observed. The nutrition of the skin, except in purpuric cases, is usually fairly maintained; bed-sores in cases well cared for are of rare occurrence. A clammy sweat is frequently seen, especially upon the face.

The symptoms of an improvement in the condition of the patient suffering from nausea and vomiting of pregnancy are a diminution in the nausea and the emesis; the ability to take and to retain food; a normal condition of the excretions, especially of the urine; the absence or the diminution of excessive perspiration; considerable periods of sleep without emesis, and the absence of substernal distress, especially at night. The pulse falls gradually to 100, and the temperature remains normal. Symptoms of danger in these cases are the continuance of the nausea and vomiting and the gradual development of the signs and symptoms of pernicious anemia. Among the most important of these are a persistently rapid, feeble pulse, substernal pain and distress, and coffee-ground vomit.

The pathological anatomy of these cases may be divided into—first, those of the organs of the body other than the generative organs; and, second, those of the uterus and its appendages. In the first class of cases it is evident that lesions which may produce obstinate nausea and vomiting in the non-pregnant may also by coincidence be present in gravid women. Thus, cancer of the stomach; chronic gastritis, whether gouty, alcoholic, or caused by arterio-sclerosis; nephritis in its various forms; brain-tumor; chronic displacement of the stomach by the pathological condition of adjacent viscera; hysteria producing emesis; emaciation, vomiting, and acute yellow atrophy of the liver,—may be present and cause vomiting in pregnant patients. Of these conditions but one stands in a possible causal relationship, and is by some considered dependent upon the condition of pregnancy. It has been shown by Lomer and by Frerichs that this disorder may affect pregnant women in forms of varying severity, and that the milder cases of acute yellow atrophy of the liver, in which death does not occur from this complication, often show themselves through nausea and vomiting only.

FIG. 144.—Vomiting of pregnancy. Cyst in anterior wall of cervix (Davis).

As regards the changes to be met with in the genital organs in these cases, they are, first, those of position; and, second, those of structure. In the former we have acute and chronic dislocations of the uterus. Commonest among these dislocations is retroversion, which generally follows straining or lifting, and in which the relation between the dislocation and the nausea and vomiting is that of evident cause and effect. This complication is serious in proportion to the condition of the surrounding parts: if no adhesions bind the uterus in its abnormal position, the reduction of the dislocation is readily effected and the exciting cause is at once removed. Where, however, the pregnant womb becomes retroverted and bound down by adhesions in the process of pelvic inflammation, the pathological condition is far more complicated and grave. Chronic dislocations of the pregnant womb are those in which that organ as a whole is forced downward in the pelvis and impacted with its fundus against the symphysis pubis. This condition of the womb is the result of persistent wearing of tight clothing before and after the occurrence of pregnancy, and it has been well described and its importance has been urged by Grailey Hewitt in a brochure entitled *Severe Vomiting during Pregnancy*, published in London in 1890. This condition of impaction is not infrequently accompanied by congenital malformation of the pregnant uterus, evidenced by extreme anteflexion, with a pathological condition of great importance in the cervix. It has repeatedly been observed in such cases that the cervical canal was tightly closed and that the tissues of the cervix were excessively dense and resistant. Attention has recently been called by Davis,[120] in a case of this sort, to a condition of excessive development of connective tissue in the cervix accompanied by the presence of a retention-cyst of considerable size in the anterior wall of the cervix (Figs. 144, 145).

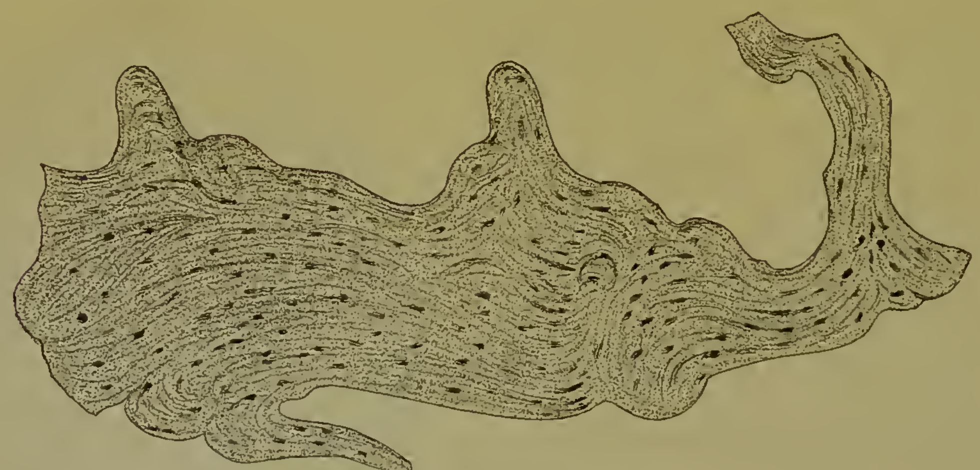

FIG. 145.—Vomiting of pregnancy. Dense connective tissue in cervix (Davis).

In addition to these gross changes in the uterus, tumors of the ovary and enlargement of the tubes have been observed in cases of nausea and vomiting of pregnancy. Microscopic examination of the endometrium in many of these cases has demonstrated the presence of endometritis of various forms: that this of itself is a cause of the nausea and vomiting is not demonstrated; the condition is apparently the accompaniment and the result of the congenital malformations or dislocations already described.

Through the researches of Lindenmann of Moscow[121] we are in possession of the interesting results of microscopic examinations upon the tissues of a mother and her fetus perishing from pernicious vomiting complicated by polyneuritis. A gross examination revealed enlargement of the spleen with the appearance usual in inanition, with cirrhotic kidneys and liver. Microscopic examination revealed neuritis of the phrenic, pneumogastric, median, and peroneal nerves, being especially well marked in the phrenic. The liver showed fatty degeneration and cloudy swelling. The blood-vessels of the spleen were dilated, and the blood-corpuscles could not be stained by coloring agents. The epithelium of the kidneys showed fatty degeneration. The organs of the fetus exhibited fatty degeneration of the liver and necrosis of the kidney. The entire pathological picture was that of infection by a toxine, and Lindenmann considers the infection as auto-intoxication. In his control-experiments upon this case he describes interesting observations on the pathology of inanition in animals, and from these comparative studies he excludes simple inanition as a cause for the lesions in pernicious nausea.

The rational *treatment* of the nausea and vomiting of pregnancy is impossible without a thorough knowledge of the condition, first, of the patient's processes of assimilation, and, second, of the condition of the genital tract. The patient must be examined thoroughly to exclude any cause for the malady that lies outside the genital tract. This examination will eliminate the rarer complications of this disorder. A thorough and painstaking examination of the uterus, its size, shape, consistence, position, and the condition of the pelvic tissues surrounding it, is then imperative. In cases where the sensitiveness of the patient is so great that an examination aggravates the vomiting, anesthesia by chloroform or by bromid of ethyl is indicated. The physician in this examination must broadly differentiate between two conditions: he may find a simple dislocation of the uterus in retroversion or prolapse of the uterus, and partial impaction anteriorly; or he may detect a congenital malformation manifested in sharp anteflexion with thick and resisting cervix, or a retroversion bound down by pelvic adhesions. In the first and simplest of these conditions the restoration of the uterus to its normal position is indicated, and is almost invariably successful in relieving the condition. The explanation of this relief seems to be that the constant irritation to the reflex nervous system which pressure upon the pelvic nerves maintains is relieved by replacing the uterus, hence the pathological phenomenon ceases. If retroversion be present, the bladder and the rectum should be emptied thoroughly, the patient placed preferably in Sims' position, when, under anesthesia if necessary, the perineum should be retracted and the cervix drawn downward and backward with one hand, while with the fingers of the other hand the fundus should be directed gently upward and forward. Reposition having thus been effected, it is well to sustain the uterus in its position, at first by a packing of antiseptic gauze, then by tampons of carded wool. If the pregnancy be an early one and no pathological condition in the pelvis be present, a Hodge pessary may be worn to advantage. In prolapse and anterior impaction of the gravid uterus a thorough emptying of the bowel is of great importance before attempting replacement. The uterus should then be raised gently upon the fingers of the physician, and if difficulty and resistance be experienced, the knee-chest position should be tried. It is often observed in these cases that but slight change in position is sufficient to relieve the patient, and this gain, however small, is to be maintained by tamponing the vagina with antiseptic soft material. As soon as the patient's strength permits, if the uterus is not in its normal position, it should again be raised by gentle manipulation and the tampon be replaced. In this manner, under thorough antiseptic precautions, it is possible by gentle manipulation to restore very nearly to its normal position a uterus prolapsed and anteriorly impacted.

In cases where the physician detects an abnormal condition of the cervix, the result of congenital malformation and pathological processes, the case is far more serious and the treatment is more difficult. It is here that dilatation of the cervix, found by Copeman,[122] by a fortunate accident, to be efficient, is the method of treatment to be employed. The profession is familiar with Copeman's effort to induce labor in a patient pregnant six months and almost dead from nausea and vomiting. Having dilated the cervix as much as he could with his fingers, he attempted to rupture the membranes and failed. The improvement caused by the dilatation was so great that no further interference was practised, and the patient recovered. There can be no question but that in cases where a pathological condition of the cervix is present, dilatation is demanded, and without delay. The physician should not be misled by a soft condition of the external os, for oftentimes a chronically congested mucous membrane and hypersecretion of the glands of the cervix give to the casual observer the impression that the cervix is softened. While this may be true of its external portion, the internal os will be found tightly contracted and its walls in a condition of dense resistance. Dilatation should be practised under anesthesia, preferably by chloroform or by bromid of ethyl. The finger is a safe instrument, but in cases where the tissue resists the finger it is necessary to use, first, steel-bladed dilators, as is done by Wiley and others, and then complete the dilatation to the point of admitting the finger by solid metal bougies. This procedure of course exposes the pregnancy to danger of interruption, and rupture of the membranes may occur during the dilatation. The physician should be prepared for this complication by having ready a suitable curette and douche-tube with which to thoroughly curette and douche the uterus. Following the complete removal of the ovum by the curette and douche, the uterus should be packed with iodoform gauze and be carried well up into the pelvis. In undertaking to treat a case of the nausea and vomiting of pregnancy it is impossible for the physician to do his duty without making a thorough examination, and without practising interference such as his judgment may dictate. If he is hampered in this examination by the prejudices of his patient, he must decide whether to place the responsibility upon her and her friends or to retire from the case.

In milder cases, where a condition of simple irritability and hypersecretion in the os and cervix are detected, local applications to these parts are of great value. Where the mucous membrane is angry and red, following a cleansing douche of creolin and green soap, the physician may apply nitrate of silver by pencil with advantage. In raising a simply dislocated uterus in the pelvis antiseptic and analgesic ointments may be incorporated with the tampons employed.

Thus an ointment of belladonna, iodoform, and morphia is sometimes of use in these cases. If excessive secretion be present, iodoform, belladonna, and glycerol of tannin form a useful mixture.

The medicinal treatment of the nausea and vomiting of pregnancy consists, first, in eliminating by examination the necessity for operative interference, or in promptly remedying a pathological condition of the uterus. A strict control of the patient is then an absolute necessity, and here the services of a skilled and competent attendant are of the greatest value. The patient should be put to bed and her strength preserved in every possible way. The subject of nausea and vomiting should not be dwelt upon with her. She should be fed by carefully-prepared nutriment—if possible, by the mouth—at regular intervals. If the stomach is non-retentive, rectal injections of nutritive substances are demanded. Among these substances are various preparations of beef in the form of peptonoids, peptonized beef, beef-juice combined with brandy, with milk peptonized and pancreatized. If it is desired to administer alcohol and the stomach cannot tolerate dry champagne or brandy and soda, brandy may be given by rectal injection. The list of remedies which have been employed by administration in the stomach in these cases is excessively great, and it shows how comparatively unimportant all have been in radically relieving the disorder. Where evidence of chronic catarrh of the stomach was present, lavage of the stomach has been found of the greatest value. The soft-rubber stomach-tube should be passed, and a solution of sodium chlorid, sodium salicylate, or a dilute solution of bicarbonate of sodium should be employed. The administration of animal ferments in connection with food is also of great value. Thus, ingluvin, pancreatin with sodium bicarbonate, with nux vomica, or strychnia and pepsin, are of decided value. Solid food must not be attempted until the patient's strength has considerably improved and the condition of the tongue warrants its trial. It is well at times to consult the patient's appetite and craving when solid food is given, if this craving does not call for articles of an injurious character. When solid food is taken, scraped raw-beef sandwiches, oysters, junket, milk with lime-water or with Vichy, and freshly made broth in which bread is dipped, are usually of value.

Drugs are of use in the treatment of this complication only in so far as they assist in preserving the patient's strength. It is folly to drug a patient with narcotics while the physician is ignorant of the position and condition of the pelvic organs, and the prolonged administration of morphia is often simply a mask for negligence or for incompetence. It is much better to procure sleep by the administration of alcohol per rectum by night, by sponging with warm water and bathing whiskey, and by securing for the patient perfect repose, than by the administration of depressing remedies. Where narcotics are indispensable, morphia and atropia or codeia are undoubtedly the best. In extreme cases prompt and vigorous stimulation must be brought into play to tide the patient over a collapse which may follow the dilatation of the cervix or the emptying of the uterus. Here the hypodermic use of strychnia, digitalis, atropia, and alcohol, the transfusion of saline solution, the application of electricity to the spine, the application of heat to the base of the brain and about the trunk of the body, are all of value.

The explanation of those cases in which spontaneous cure of this condition occurs is to be found most reasonably in spontaneous reduction of dislocations of the uterus. Experience has shown that it requires but a slight change in the position of this organ to alter a state of irritant pressure to a condition in which no irritation, or but little, is produced. There is certainly no other rational explanation, from our knowledge of pathology, for these cases. The folly of waiting for such a change to occur without using every effort to place the uterus in proper position is self-evident. It is remarkable that this most important point in treatment—namely, the securing of a proper position of the uterus—should have been considered as a last resort. That such a change may often be produced by the posture of the patient only is illustrated in a case reported by Grant,[123] who as a last resort elevated the hips of a patient upon pillows, whereupon her vomiting ceased. The fact that curetting the uterus in urgent cases is followed by immediate relief is well illustrated by Roland[124] and by Blane.[125] The excellent results following the reduction of

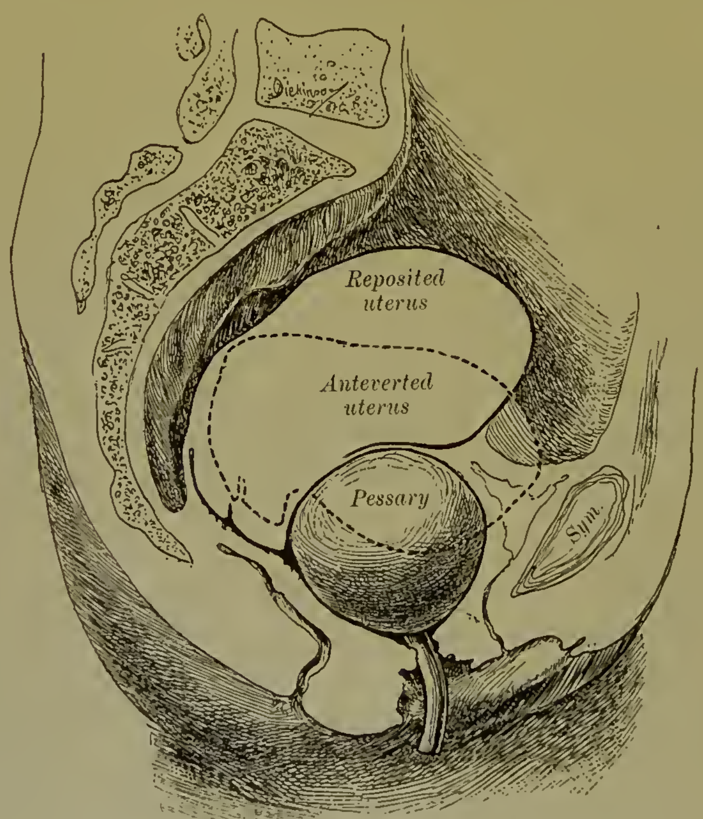

FIG. 146.—Air-ball pessary in position and raising the uterus.

dislocations of the uterus find abundant illustration in Hewitt's *Reports*, in which the use of the Gariel air-ball pessary is described and fully illustrated. This instrument is of value when the finger has dislodged the anteriorly-impacted uterus, and under antiseptic precautions its use has been attended with excellent results. The accompanying illustration (Fig. 146) shows the air-ball pessary in position and raising the uterus in the pelvis. Kingman[126] also describes cases in which the reduction of uterine dislocations has terminated nausea and vomiting.

Ptyalism complicating this condition has been well described by Ahlfeld,[127] who believes that these cases are primarily neurotic in origin, and treats them accordingly. With the same view of the causation of vomiting, Gunther[128] treats these cases by galvanism, the positive pole being placed against the cervix, the negative between the eighth and twelfth dorsal vertebræ. From 2½ to 5 milliampères were employed for from seven to ten minutes; so long as the current was uninterrupted he did not observe danger of disturbing the pregnancy. Sänger and Hennig[129] describe cases in which the exciting cause of vomiting was a pathological condition, either in the uterus or some abdominal organ.

Ascites complicating pregnancy may arise from a lesion of the abdominal viscera interfering with the return circulation and also with the lymphatic circulation of the peritoneum. Pregnancy itself sometimes occasions ascites through a pathological condition which affects the peritoneum of the mother and the amnion of the fetus by a similar process. An interesting case illustrating this condition is reported by Florentine.[130] The patient was a young woman married three years who had borne one living child and had one abortion. The cessation of menstruation was followed by obscure pain in the abdomen, increase in size, and the evident presence of fluid. Pressure-symptoms became so pronounced that suffocation was threatened and pains like those of labor supervened. The membranes were ruptured, when the entire fetus with a large amount of amniotic liquid was suddenly expelled. Distention of the abdomen was relieved by paracentesis. The presence of an ovarian cyst was then diagnosticated and the tumor removed a month later. Recovery ensued.

Tubercular peritonitis complicating pregnancy is also a cause of ascites, and it may develop gradually as gestation advances. The treatment of abdominal dropsy complicating pregnancy is, preferably, by exploratory incision. If a tubercular process be present, the prognosis for very great improvement, if not recovery, is excellent. If a pathological condition of the lymphatic system of the peritoneum is the cause of the condition, free drainage by incision is much the safer treatment. The immunity displayed by pregnant patients to operative procedures when properly conducted renders such interference safe and highly appropriate.

Phantom pregnancy, or **pseudo-cyesis**, may result from a strong desire for pregnancy in a patient suffering from ascites. An illustrative case is reported by Clay.[131] Phantom pregnancy without pathological lesion is not a rare condition. Observed in nervous patients who strongly desire pregnancy, and who are usually past the time of greatest reproductive activity, its symptoms are the subjective symptoms of normal gestation. The *diagnosis* and *treatment* of this condition are completed by a thorough examination, and whenever the patient will submit to examination under an anesthetic the cure is usually complete. It is well in such cases to have a friend of the patient present at the examination to personally witness the disappearance of the abdominal tumor as anesthesia proceeds. Illustrative cases are found in the literature of the subject, and among them is that of Johnston.[132]

Acute yellow atrophy of the liver in the pregnant woman is an infectious disease of uncertain origin. Out of 143 cases of this disorder Thierfelder observed thirty during pregnancy. Spæth saw it but onee in 16,502 pregnant women. Epidemics of this disorder have been reported by Kerksig, Charpentier, and Bardinet. Lomer's excellent paper upon the subject, and the reports of Matthews Duncan[133] describe this complieation fully. Its *symptoms* are those of jaundice, hematogenic and hepatogenic, with evidence of profound intoxication from the absorption of septic material and toxins. On palpating the abdomen the area of liver-dulness is diminished; after the stage of incubation, lasting from three to five days, the patient has gastric and intestinal catarrh with rigor, pains in the head and back, and fever. Albuminuria is often present; in severe cases there is great tenderness over the liver and abdomen. Occasionally the disease results in death before delivery. As a rule, patients come into labor or abort with a fatal issue. In a case recently observed by the writer the profound jaundice of the mother was reproduced in the bright yellow color of the amniotic liquid and the deep orange staining of the fetus and its appendages. This patient had high fever before delivery, and died in septic coma shortly afterward. The cause of aeute yellow atrophy with malignant jaundice is blood-poisoning from acute septie infection. Its *prognosis* is exceedingly grave, and the treatment of these cases consists in the effort to terminate pregnancy promptly, to arouse the secretions of the intestinal canal, and to support the patient's strength.

The milder form of *jaundice during pregnancy* may result from impaction of feees, catarrh of the bile-ducts, pressure of the pregnant womb upon the liver, and the physiological hyperemia which the liver shares in common with other abdominal viscera. Failure in exeretion by the kidneys in greater or lesser degree is often noted in these cases, and the development of gall-stones is a not infrequent aecompaniment. Where the disorder is promptly recognized, and the gastro-intestinal tract is subjeeted to proper and efficient treatment, it is often possible to avoid fatal issue. Winter deseribes an illustrative ease[134] in which a multigravida who had suffered from malarial intoxieation was attacked with jaundice. After a violent illness of six or eight days, with great gastric disturbance and vomiting, premature labor oceurred, after which the mother recovered. The *treatment* of this condition is the medicinal treatment appropriate for these eases in the non-pregnant. Premature labor is to be expeeted in well-marked eases, and in proteeting the interests of the mother no effort should be made to avoid it.

Gastric ulcer complicating pregnancy has been observed by Robert Koch[135] in two patients, each of whom suffered from profuse vomiting of blood accompanied by abdominal distress. In one, the milder case, pregnancy was interrupted and a living child was born. In the other the patient collapsed after vomiting blood freely, and, although she rallied and ultimately recovered, her child was stillborn.

Appendicitis in pregnancy has been well described by Mixter.[136] Premature labor followed the attack, and an abdominal tumor demanded operation. The appendix was found at the lower end of the kidney, its position having possibly been altered by the pregnant uterus. Fecal concretions were present. The patient recovered after operation.

Albuminuria and **peptonuria** are variations in the metabolism of the pregnant patient, and are of interest and importance to the obstetrician. The clinical importance of the presence of serum-albumin in the urine in pregnancy has been greatly exaggerated, and a closer study of the excretions has demonstrated its very limited significance. In accordance with the preciseness and the delicacy of the tests employed serum-albumin has been found to be present by Schroeder in from 3 to 5 per cent.; Ingerslev, 4.8 per cent.; Flaischlen, 2.6 per cent.; Meyer, 5.4 per cent.; while Lantos, in an interesting series of observations at Budapest,[137] found albumin in 18 per cent. of pregnant women and in 60 per cent. of those recently delivered. In thirty-nine fatal cases, in which the urine had contained albumin, the patients had suffered neither from eclampsia nor from nephritis. The kidneys in these cases were very pale and anemic. Lantos is convinced that albuminuria is very common among pregnant women, that it results from reflex irritation of the vaso-motor nerves of the renal vessels, and that it has no pathological significance; it may, however, be of value as a sign of pregnancy in making a differential diagnosis. Peptone has been found in the urine of pregnant women, and it is thought by some to be an evidence of the death of the fetus. Thomson[138] could not observe that peptone was characteristic of the pregnant condition, nor that it is a symptom of a macerated or a dead fetus. According to his researches, peptone appears intermittently without appreciable cause in the urine during pregnancy and after labor. From the researches of Koettnitz,[139] who examined the urine in 31 cases of pregnancy, we may believe that peptone is not a sign of fetal death. Its presence seems a physiological phenomenon, only becoming pathological when this substance is found in excess. In complicated labor where maceration of the fetus and severe visceral disease of the mother are present it has been found.

The treatment of albuminuria and peptonuria during pregnancy consists in interference and rational hygiene. As most pregnant patients eliminate insufficiently, such forms of diet as agree best with the individual case should be enjoined. The peculiarities of the individual should be studied closely, and the whole range of therapeutic and medical art will frequently be taxed to aid the patient in solving the difficult problem of nourishing herself and her unborn child. Many specific treatments have been urged for albuminuria; among them is the benzoic-acid treatment, sometimes combined with bicarbonate of potassium. Various purgatives have been given in these cases, the best purgatives being those that do not introduce into the blood of the patient a large amount of potassium salts. In general it may be said that the presence of albumin or of peptone in the urine of a pregnant patient is not of itself a pathological phenomenon, and it is only when the presence of albumin is associated with casts and deficient excretion, as indicated by deficient urea, that albumin becomes an indication of disease.

Abnormal conditions of the mouth and teeth during pregnancy may occasion considerable distress and inconvenience to the patient. The gums frequently become abnormally soft, and a condition known as "white caries" is often seen in the teeth. The edges of the gums are thin, pale, somewhat shrivelled in appearance, and retracted from about the teeth. A prominent ridge along the free border, often of deeper tint than the surrounding membrane, is sometimes observed. In other cases the gums are reddish and are apparently softened, exuding a thin fluid or pus from around the neck of the tooth. Such a condition does not imply neglect of cleanliness, but it seems a passive congestion and transudation from the tissues. It has been shown by Elliott[140] and others that this condition of caries in the teeth results from the altered secretions in the oral and buccal cavities. The secretion of saliva is much increased, ptyalin being often absent. The saliva early in the day is often of acid reaction, and this is thought to have a potent influence upon the development of caries of the teeth. This disorder is sometimes known as "brown caries" when extensive discoloration of the teeth is present. The margins of cavities in these cases are black. A line of brownish discoloration sometimes occurs upon the upper incisors or the canines. The enamel is opaque. This form of caries generally begins in the region of the bicuspids of the upper or lower jaw, and is usually found among patients of the lower classes. Softening of the dentine of the upper bicuspids and molars is sometimes observed, apparently because the bicuspids are those teeth against which fluid is most forcibly ejected in the emesis of pregnancy; they are also in contact with the tongue at rest. General softening of the teeth without actual decay, and loosening of the teeth in their sockets from partial absorption of the alveolus, are also observed. White or soft caries is often found in an inexplicable manner in patients apparently well nourished, and in its pathology resembles osteomalacia.

Affections of the nerves of the face and the teeth often accompany the structural conditions mentioned. By some, altered nervous conditions in these parts are referred to pathological conditions in the mucous membrane of the stomach. Occasionally pain in the mouth and teeth is purely reflex from the uterus, as in a case described by Garrettson in which pain was felt about a carious tooth. Its removal brought no relief, but the healing of an ulcerated cervix uteri caused the pain to disappear.

The treatment of these conditions is to be found in a proper attention to the general condition of the patient. Locally, chlorate of potassium and bromid of potassium are useful when the gums are irritable. Powdered boracic acid may be brushed upon the teeth with a soft brush, or equal parts of charcoal and precipitated chalk may be used for short periods. In reflex pain, felt in sound teeth, a blister over the fourth or fifth dorsal vertebra has been of use. Absolute alcohol and collodion may be painted over a tooth attacked by soft caries. When carious cavities require filling, this should be accomplished with as little distress to the patient as possible, and the filling should be of a non-irritating character. When a tooth occasions severe suffering during pregnancy there are many reasons for advising its removal, as pregnancy has been interrupted as the result of such distress, while the presence of continued pain has an undoubted influence upon the development of the child.

Exophthalmic goitre and **simple goitre** may develop rapidly during pregnancy, and by the associated changes which occur in the circulation may result disastrously to the fetus. Thus in a case reported by Haberlin[141] the rapid development of exophthalmic goitre was accompanied by premature separation of the placenta, with death to the fetus at eight months. The termination of labor was followed by immediate cessation of the development of the goitre. In severe cases such patients become excessively nervous, the hands tremble violently, palpitation of the heart and a sense of constriction about the throat are present, with considerable emaciation. Vomiting is also a symptom in well-marked cases. While palliative treatment may temporarily relieve these patients, if the symptoms be urgent a removal of the goitre should promptly be undertaken.

Abnormal conditions of the blood are not of very infrequent occurrence. The normal condition of the blood during pregnancy in ill-nourished women is that of temporary anemia, which soon gives place to a development of physiological plethora and hyperemia. It has been shown by Dudner[142] and others that so soon as the balance of nutrition becomes established a steady increase in the amount of corpuscles and hemoglobin is to be observed. Narse[143] found the specific gravity of the blood during pregnancy to be 1025. The amount of fibrin increases, while the quantity of salts and hemoglobin diminishes. Winckelmann[144] found that as pregnancy advances the quantity of hemoglobin increases. Schroeder[145] considers anemia in pregnancy as the exception and as a pathological condition, while neither he nor Meyer[146] observed a great decrease in hemoglobin or corpuscles. The observations of Ingersleff,[147] Fehling,[148] and Meyer[149] upon the comparative composition of the blood in the pregnant and the non-pregnant show that in the former the number of red corpuscles is slightly decreased and also the amount of hemoglobin during early pregnancy.

Anemia in the pregnant is produced by the same causes which influence the non-pregnant. Its recognition is effected by the same methods of examination and diagnosis employed in the study of internal medicine. The condition of anemia complicating pregnancy was early recognized by American physicians, whose contributions to the literature of the subject are among the first. Cazeaux and the French school ascribe to anemia many of the disorders of pregnancy. A curious aversion to the treatment of anemia during pregnancy by methods usually employed in non-pregnancy is shown in the records of a malpractice suit reported in 1871 by Woodman to the Obstetrical Society of London, when a physician was sued for using the ammonio-citrate of iron in the treatment of this condition. It was claimed that he had thus produced abortion. The verdict of the society was in favor of the physician. Gusserow[150] reports five cases of extreme anemia in the pregnant state. The eighth month seemed the period most favorable for the development of this complication. Bischoff and Biermer report cases of oligemia and anemia with cachexia at about this period.[151] Cameron's excellent description of leukemia during pregnancy[152] includes a case with a marked family history of leukemia. Sänger[153] reports the case of a leukemic mother who bore a healthy child, and also of a healthy mother who gave birth to a leukemic child. Davis[154] reports the case of a multigravida seized with hematogenic jaundice. Examination of the patient's blood showed the condition of pernicious anemia. The blood of her fetus was found to be normal. Under treatment her condition greatly improved after delivery.

While it is possible for these patients to bear healthy children, still pregnant women suffering from various forms of anemia and leukemia are subject to dangerous symptoms as pregnancy advances and as the pathological condition of the blood becomes pronounced. Important symptoms are epistaxis, hematemesis, and melanemia, with the development of a purpuric condition. Attention has been drawn by Laubenberg[155] to the severity of this complication and to its almost inevitable interruption of pregnancy, and he urges the early induction of labor as the duty of the physician.

The most serious condition of the blood attacking the pregnant patient is *purpura hæmorrhagica.* Its occurrence and severity in pregnant women are explained by the sympathy existing between the utero-ovarian and the tegumentary systems of the body. This nervous connection is often observed in the skin eruptions which accompany disorders of menstruation. As has been shown by Immermann, the complication is sporadic in pregnant patients, and it occurs without regard to family history or to previous condition. Phillips[156] collected cases illustrating the absence of previous history of hemophilia in these patients. In some of them hard work and insufficient nourishment seem to have produced the disorder. Profound mental disturbance has occasionally been followed by this condition. In Phillips' case the child showed no symptoms of purpura, and the mother recovered rapidly after labor. Kaczmarsky[157] reports a case in which severe sacral pain during pregnancy was the first symptom. The birth of a dead fetus followed speedily, and the mother perished from hemorrhage. Dohrn reports twin pregnancy with this complication, with severe postpartum hemorrhage and death. Both these patients had previously been healthy. Wernicke, Recklinghausen, Hanot, and Luzet offer evidence which seems to prove, on the one hand, that the disorder is a form of infection by bacilli; on the other hand, the cases described by Dohrn[158] do not point to this condition as causative. The immunity of the fetus in these cases is inexplicable and of interest. Microscopic study made of the blood in this complication by Gibbon during the height of an attack of purpura showed that the red corpuscles contained numbers of black granules massed together in some of the cells. These bodies increased as the disorder became severe, and diminished in convalescence. The number of corpuscles early in the disease was over 5,000,000 per cubic millimeter, this number being greatly diminished as the disorder made progress. The white corpuscles became excessive, and the hemoglobin fell to 30 per cent., afterward rising to 60 per cent.

The treatment of anemia and leukemia complicating pregnancy consists in securing thorough elimination, and in the employment of those forms of treatment found useful in the non-pregnant patient. Osler[159] obtained good results from the persistent use of arsenic, the free use of iron, the inhalation of oxygen, systematic and forced feeding, and, of great importance, the correction of the condition of gastro-intestinal catarrh so often found in these cases. The patient's strength should be conserved in every possible manner. Should purpuric eruption develop, with hemorrhages, antiseptic dressings must be applied over these areas, and care should be taken that bichlorid of mercury is not employed, the susceptibility of anemic pregnant patients to mercurial poisoning being a contra-indication to its use. Bichlorid of mercury in minute doses should be given when a possible syphilitic taint is suspected as a complication. The prompt induction of labor is required in cases where the disorder steadily increases in severity, although this procedure when the patient has reached a critical condition is useless and unjustifiable. If done at all, labor should be induced promptly and while there yet remains sufficient strength to justify a hope that the patient will rally.

Cardiac disease complicating pregnancy is not infrequently observed. In those patients who are well nourished slight cardiac lesions are frequently undetected during pregnancy and cause no embarrassment at labor. A physiological hypertrophy of the heart occurring during pregnancy is well described by Larcher, who found hypertrophy of the left ventricle in pregnant women. Other observers assert that this hypertrophy is associated with dilatation of the right heart. Istria[160] and others maintain that pregnancy often induces endocarditis, and other observers have noted the development of endocarditis after repeated parturition. The most fatal of these lesions in the pregnant patient is mitral stenosis. Marshall[161] and Duckworth demonstrated the remarkable preponderance of this form of heart disease in women. Direct cardiac symptoms are comparatively few, consisting of palpitation, sometimes pain and depression. Bronchial catarrh is generally observed. The want of concurrence between the cardiac systole and the impulse given by the pulse-wave is an interesting and important diagnostic point in these cases. Cases reported by Fritsch, Budin, Macdonald, and Malherbe illustrate the occurrence and fatal termination of this disorder. The results of this lesion in 14 cases given by Macdonald were death in nine. Porak saw eight fatal cases out of 13. Remy in 19 cases found eleven fatal. In double mitral lesion seven out of Hart's 8 cases perished. In one-half of the cases recorded pregnancy has been interrupted without interference. Half of these patients died and half of them recovered. The predominance of pulmonary symptoms in mitral stenosis should be borne in mind in making a diagnosis and in instituting treatment.

While the mortality of pregnancy complicated by mitral stenosis is more than 50 per cent., aortic lesions give a mortality of 23 per cent. Mitral insufficiency is accredited with 13 per cent., while in complex lesions of the heart a mortality of 50 per cent. is a conservative estimate. The prognosis for the continuance of pregnancy and for the life of the child is distinctly unfavorable. Mackness[162] reports a case of pregnancy complicated by aortic and mitral disease in which labor was induced. Partial recovery ensued. The patient's condition of prostration became so excessive during the latter portion of her pregnancy as to require vigorous stimulation. She was greatly prostrated by persistent emesis and paroxysms of oppression, which were relieved by the administration of nitrite of amyl.

Merklen[163] reports an illustrative case in which pulmonary tuberculosis was associated with stenosis at the mitral orifice. Dilatation of both sides of the heart was present, with general anasarca and exaggerated pulmonary congestion. Venous stasis in the kidneys was well pronounced. Pulmonary hemorrhage occurred, and it was a temporary relief to the patient.

Hemoptysis complicating pregnancy may occur from simple pulmonary congestion in cases of valvular heart disease, or may result from disease of the parenchyma of the lung, most commonly tubercular. Martin[164] describes the case of a patient four months pregnant who suffered from obstinate and persistent hemoptysis. There were pulmonary signs of consolidation anteriorly below the right clavicle. Bleeding occurred at about the time when the patient would have menstruated had she not been pregnant. Epistaxis subsequently developed, and later a profuse red rash, resembling that of scarlatina, covered the body. This rash gradually faded, and was not attended by fever or any signs of other complication. Pulmonary signs gradually improved, especially under treatment by a succession of blisters upon the chest, that gave marked relief. The patient entirely recovered and went to the usual termination of pregnancy.

Hemorrhage from the Uterus.—The fact that profuse hemorrhage from the uterus may occur during pregnancy and still the patient go on to the end of gestation is well illustrated in a case described by Robertson.[165] His patient was a multigravida who had several hemorrhages so severe as on each occasion to cause the supposition that abortion had occurred. Her pregnancy continued to a successful termination.

Internal hemorrhage is observed as a complication in patients suffering from nephritis during pregnancy. To such an extent may symptoms of shock and acute anemia be present that placenta prævia has been suspected in these cases. Schauta[166] reports the case of a woman, aged forty-four, who had borne nine children, and in whom profuse hemorrhage caused a diagnosis of placenta prævia. Although the patient was not in labor, the os was sufficiently dilated to permit a diagnosis to be made that placenta prævia was not present. Transfusion by normal salt-solution was immediately performed, and when the patient rallied, as the child was dead, it was extracted by craniotomy. A large amount of clotted blood was found in the uterus and vagina. The patient succumbed from the hemorrhage shortly after delivery. The post-mortem examination revealed chronic nephritis as the only complication accounting for the condition. Winter observed three similar cases in Schroeder's clinic.

3. Acute Infections during Pregnancy.

The condition of pregnancy renders the patient peculiarly liable to the rapid development of infective germs. The body of the pregnant woman presents that condition of plethora and hyperemia in the viscera that invites the growth of bacteria. It is not, then, difficult to understand why these complications of pregnancy are among the most severe. First among these disorders may be considered those in which the infection usually gains access to the body through the genital tract. Such disorders are gonorrhea, syphilis, and cancer.

Gonorrhea is by no means an uncommon complication of pregnancy, and in an ignorant woman no intelligent history attracting the attention of the physician to the condition present may be afforded. The complaint, however, of difficulty in micturition and of burning and irritant discharge should occasion an examination, when specific vaginitis may be detected. The symptoms and treatment of this disorder in the pregnant are essentially those in the non-pregnant, but the pathology of the condition is more complex and of greater import. Not only may the gonococci infect the mucous membrane of the vagina, and possibly cause abscess of Bartholini's glands, with occasional acute inflammation of the rectum and the surrounding tissues, but the endometrium also may be attacked, and even the fetus may be infected *in utero*, by the gonorrheal virus. Children have been born with gonorrheal ophthalmia and under circumstances which precluded the possibility of infection during birth. Such infection, however, is of comparatively little importance when compared with the dangers arising to the mother from the development and retention of gonorrheal infection in the tissues about the uterus and in the tubes and ovaries. The entire genito-urinary tract of the mother is liable to such infection, the consequences of which may not become apparent until some time after delivery. Thus, in the writer's observation a patient perished from the sudden and acute septic infection occasioned by the spontaneous rupture of a small gonorrheal ovarian abscess occurring two weeks after delivery. This patient's puerperal period had apparently been normal, and the infection must have been received before or during pregnancy. The same observer witnessed death from nephritis in which the genito-urinary tract had been the seat during pregnancy of gonorrheal infection. In this case the tubes and ovaries escaped, but the bladder and kidneys showed abundant infective germs. The presence of gonorrhea as a complication of pregnancy should lead to prompt antisepsis of so much of the genital tract as is accessible. If the bladder is invaded, it should also be subjected to the same thorough antisepsis. At the time of labor all possible precautions should be taken to avoid violence to the uterus or its appendages that may set free retained gonorrheal poison. During the puerperal period the occurrence of septic inflammation in and about the uterus should be treated promptly by intra-uterine antisepsis, or so soon as possible by abdominal incision. It is folly to treat the insidious ravages of gonorrhea in the connective tissue, the peritoneum, and contents of the pelvis occurring after labor by any but prompt surgical measures. Exploratory abdominal incision is far more conservative in these cases than delay.

Syphilitic infection during pregnancy in many cases runs the usual course of this disorder, and in others it assumes peculiar malignancy. Pathologically speaking, the virulence of syphilitic infection in pregnancy depends not only upon the patient's powers of resistance, but also upon septic germs which may be associated with the bacillus of syphilis. Some of the most malignant types of puerperal sepsis are observed in patients who become syphilitic at conception or during pregnancy. In these patients the syphilitic eruption is so masked and exaggerated by the septic element present as to occasion great difficulty in diagnosis. The writer recalls a case of this sort where close study by Kaposi was necessary to differentiate between an acute syphilitic exanthem and septic infection. Hirigoyen[167] describes the occurrence of syphilis in 34 patients, who comprised 5 per cent. of the total number of pregnancies under observation. Other statistics seem to indicate that this percentage is the usual one in pregnancy occurring in large cities.

The influence which pregnancy exerts upon women already syphilitic has been described by Fournier, who laid down the maxim that a syphilitic woman who becomes pregnant is much more likely to abort than is a pregnant woman who becomes syphilitic. The percentage also of fetal death in syphilitic women who become pregnant is much greater than among pregnant women who become syphilitic. The age of the syphilis exercises a very distinct influence upon the prognosis of the pregnancy : the longer the woman has been syphilitic before pregnancy occurs, provided she has not been subjected to efficient treatment, the worse is the prognosis for the continuance of the pregnancy and the life of the fetus. The prognosis of pregnancy is also very serious the earlier in the pregnancy the infection occurs ; thus, the majority of pregnancies complicated by syphilitic infection occurring during the first four months result in the death of the fetus. When infection occurs from the fourth to the sixth month of pregnancy 50 per cent. of children are lost. During the last three months of pregnancy the complication of syphilis results in the death of less than half of the children. General fetal mortality in syphilis is under the best circumstances 75 per cent.

The mother's health in pregnancy complicated by syphilis is liable to rapid deterioration if the syphilitic process be acute. The stimulus of pregnancy seems to exaggerate the spread of the poison and the various lesions which it causes. To be efficient, antisyphilitic treatment should begin as soon as the infection occurs, and the earlier in the pregnancy such treatment is begun the better are the results obtained. Local *treatment* of syphilitic lesions complicating pregnancy consists in thorough cleanliness and in the maintenance so far as possible of local antisepsis. Ulcers should be dusted with calomel and iodoform; the parts should be kept thoroughly clean with antiseptic douches, and the discharges from syphilitic patients should be received upon absorbent material, which is then burned. Antisyphilitic medication is to be conducted in accordance with the therapeutics of this disorder in the non-pregnant. The biniodid of mercury, the bichlorid of mercury, calomel, gray powder, and the bichlorid hypodermatically are all of use. Inunctions with mercurial ointment are found advantageous in many cases. In those patients with whom mercury does not agree iodid of potassium in combination with iodin may be used to advantage. The following mixture has proved efficacious in a number of cases:

Iodin,	gr. iv;
Iodid of potassium,	ʒiv;
Compound syrup sarsaparilla,	℥iv.

Dose, one teaspoonful after meals.

Besnier[168] obtained good results with a pill containing $\frac{1}{6}$ of a grain of bichlorid of mercury with $\frac{1}{12}$ of a grain of extract of opium and $\frac{1}{12}$ of a grain of extract of gentian, rubbed up with glycerin.

Equally important with the specific treatment of syphilis in pregnancy is the tonic treatment which these cases demand. Well-ordered feeding, in which an abundance of fat in cod-liver oil or other forms is included, and the persistent administration of iron, arsenic, nux vomica, and such substances as stimulate digestion, are of the greatest importance. The aim of the physician must be not simply to tear down diseased tissue, but to build up that which is sound. The results of such treatment are often most gratifying. The characteristic lesions of syphilis fade with great rapidity in these cases; the patient who may have repeatedly aborted goes on nearly or quite to term, and a fairly-developed and healthy child is born. Neglect, however, or inadequate treatment for these patients often results in sad ravages in the mother's tissues, resulting very frequently in fetal death.

Cancer complicating pregnancy affects the course of gestation chiefly in its local manifestations in the genital tract. In rare instances multiple sarcomata develop with great rapidity in various portions of the body, causing death by constitutional infection. In other instances cancer of the uterus by metastasis speedily reduces the patient to a condition of threatened collapse, often resulting in constitutional septic infection. In such cases the interruption of pregnancy seems of very little avail for the patient, except in so far that the malignancy of the cancerous process seems less acute if the uterus is emptied.

Typhoid infection during pregnancy seriously complicates the mother's chance of convalescence from labor, and frequently results in the death of

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the fetus. In a case described by Findlay [169] the husband had been ill for some time with typhoid infection. The patient's pregnancy was terminated at about the expected time, labor occurring with a temperature of 103° F. and the pulse 140. The uterus contracted well, although during labor intestinal peristalsis was active and the patient had diarrhea, which subsided after delivery. The secretion of milk did not occur, the breasts remaining without signs of activity. The skin of the child was shrivelled, and after a few days it showed an eruption with bullous spots, the scars of which persisted when the child had reached adult life. Pregnancy is interrupted in these cases by continued high temperature, by hemorrhage in the endometrium or in the membranes of the ovum itself, and by a depressed condition of the maternal circulation, with asphyxiation of the child. Kaminski, Zulzer, and Scanzoni observed in two-thirds of their cases the interruption of pregnancy. The fact that the fetus may become infected by the transmission of the germs of typhoid through the placenta has been demonstrated by Giglio.[170] The latter examined carefully a fetus and its appendages born from a mother suffering with typhoid fever in an epidemic at Palermo. Pregnancy terminated forty-six days after the beginning of the fever. Although the specimen seemed normal on casual examination, cultures of the maternal blood demonstrated the presence of the typhoid germ, while cultures from the milk revealed bacteria exactly resembling those obtained from a typhoid non-pregnant patient. The fetus and its appendages also contained typhoid bacilli. Boyd [171] reports a case in which a week after the fever began premature labor occurred. The patient finally succumbed after continued high temperature.

The *diagnosis* of typhoid fever complicating pregnancy presents no especial difficulty. Should the physician see the case during the puerperal period, it must not be mistaken for puerperal sepsis, nor should puerperal sepsis complicated by diarrhea be mistaken for typhoid fever. It will be remembered that in septic cases diarrhea is a not infrequent symptom. The *treatment* of typhoid fever during pregnancy should be addressed to controlling the temperature and to maintaining the patient's strength. Such cases are especially fitted for the treatment of pyrexia by the bath and pack. The latter is most efficacious where the very energetic application of cold has a tendency to prostrate the patient. No fear need be felt regarding the induction of labor by treatment addressed to controlling the temperature, for it will not be such treatment, but its failure to modify the fever, which will bring about a premature ending of gestation. The fact that in many pregnant patients suffering from typhoid the stomach is excessively irritable will lead the physician to abstain from the administration of drugs by the stomach so far as possible.

Erysipelas during pregnancy is of not infrequent occurrence, and it is grave or is slight as a complication in accordance with the accompaniment of other forms of septic germs. Facial erysipelas may occur in the pregnant patient, and even abortion may follow, without the development of puerperal sepsis. Such a result, however, is possible only when strict antiseptic precautions are observed. Erysipelas of the genital tract—or of the lower extremities, where the infective germ gains ready access to the genital tract—results almost invariably in puerperal septic infection. The symptoms of erysipelas complicating pregnancy do not differ essentially from those of the disorder in the non-pregnant patient. The *treatment* consists in supporting carefully the patient's strength, and in avoiding all unnecessary examinations and manipulations in the genital tract, as interference with this portion of the patient's body is an added risk of infection. Smith[172] reports the case of a woman six months pregnant who injured her knee. Erysipelas developed in the thigh eight days afterward, and it was followed by a large abscess burrowing beneath the muscles. Premature labor occurred at seven and a half months. The puerperal period was normal and the child survived. In a recent case of facial erysipelas under the observation of the writer the mother suffered but slight inconvenience from the infeetion, but gestation terminated prematurely, the child surviving.

Erysipelas of the face and head seems to affeet the fetus in many eases quite as markedly as in erysipelas of the pelvic organs. Cohn[173] reports a case of facial erysipelas at eight months' pregnaney. The fetus, prematurely born, showed upon the corresponding portions of the head and face an edematous red swelling which gradually faded, followed by desquamation. Examination of the infiltrated tissues for erysipelas-germs gave negative results. The child perished from multiple abscesses in the kidneys. A similar condition of the fetus has been described by Runge, Kaltenbaeh, and Stratz.

Measles.—Of about the same relative virulence as erysipelas is the infection of measles attacking the pregnant patient. The symptomatology of this disorder oecurring during gestation does not differ essentially from that ordinarily observed. If the bronchitis usually accompanying measles be severe, the incessant cough and movements of the abdominal walls thus occurring greatly increase the probability of abortion. The child may be born with an anomalous eruption or it may apparently escape. The prognosis of measles complicating pregnancy is to be based upon the severity of the infection, and espeeially the eontinuanee of high temperature.

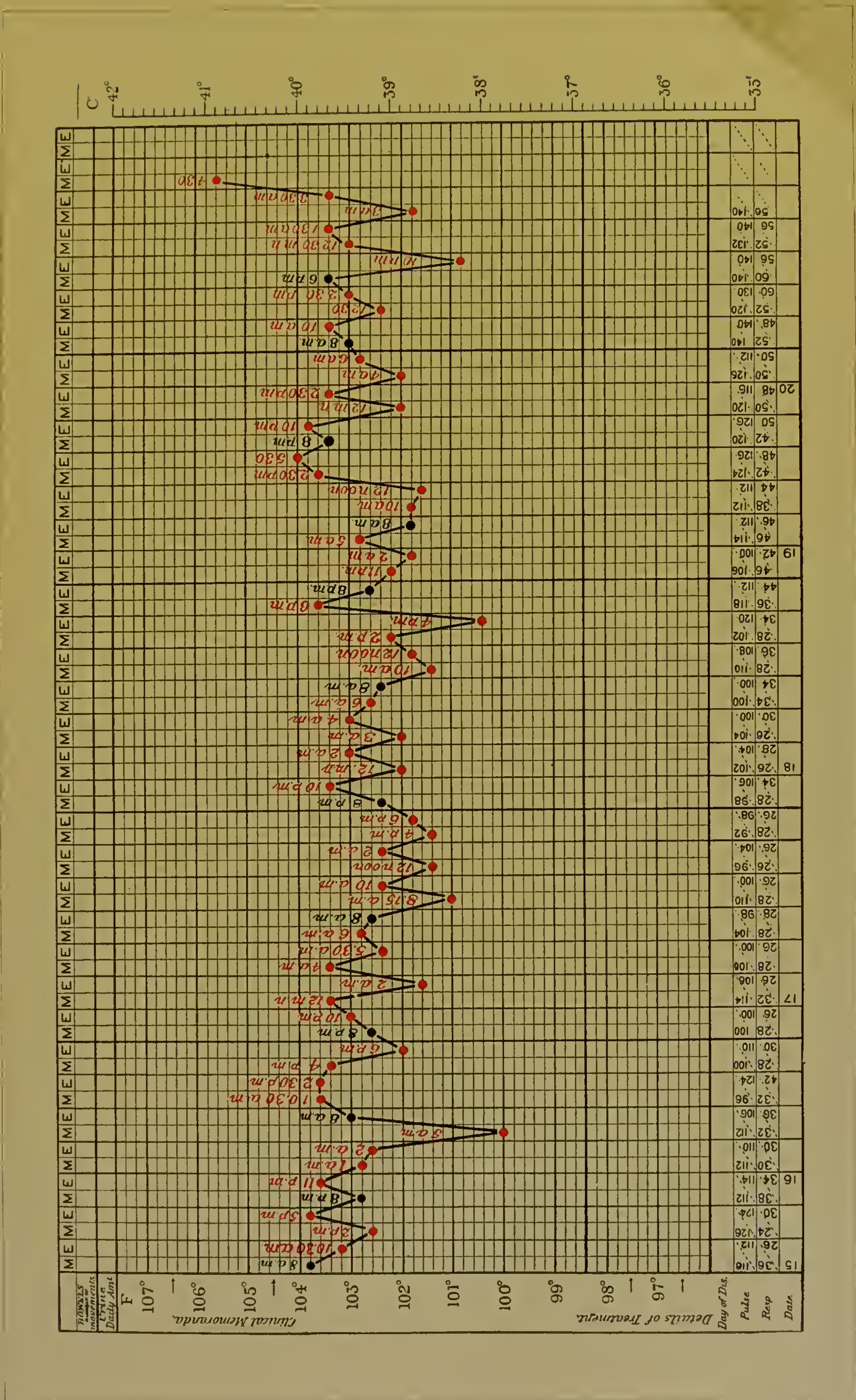
The infection of measles may be transferred from mother to child, as illustrated by a case described by Lomer;[174] the child perished from intestinal catarrh; the mother recovered. The child's eruption was characteristic on the forehead and breast a few hours after birth. Gautier[175] found measles transmitted from mother to fetus in six out of 11 cases: the maternal mortality of the 11 cases was two.

Scarlatina is a serious complication of pregnancy, and its virulence is shown from the great promptitude with which it affects the fetus *in utero*. The fact that the germ of scarlatina is morphologically held by many observers to be identical with various forms of septic bacteria renders scarlatinal infection of grave import. An illustrative case is reported by Ballantyne and Milligan,[176] in which the infection occurred during the seventh month of pregnancy. Two days later gestation ended, and the fetus was found to have scarlatina.

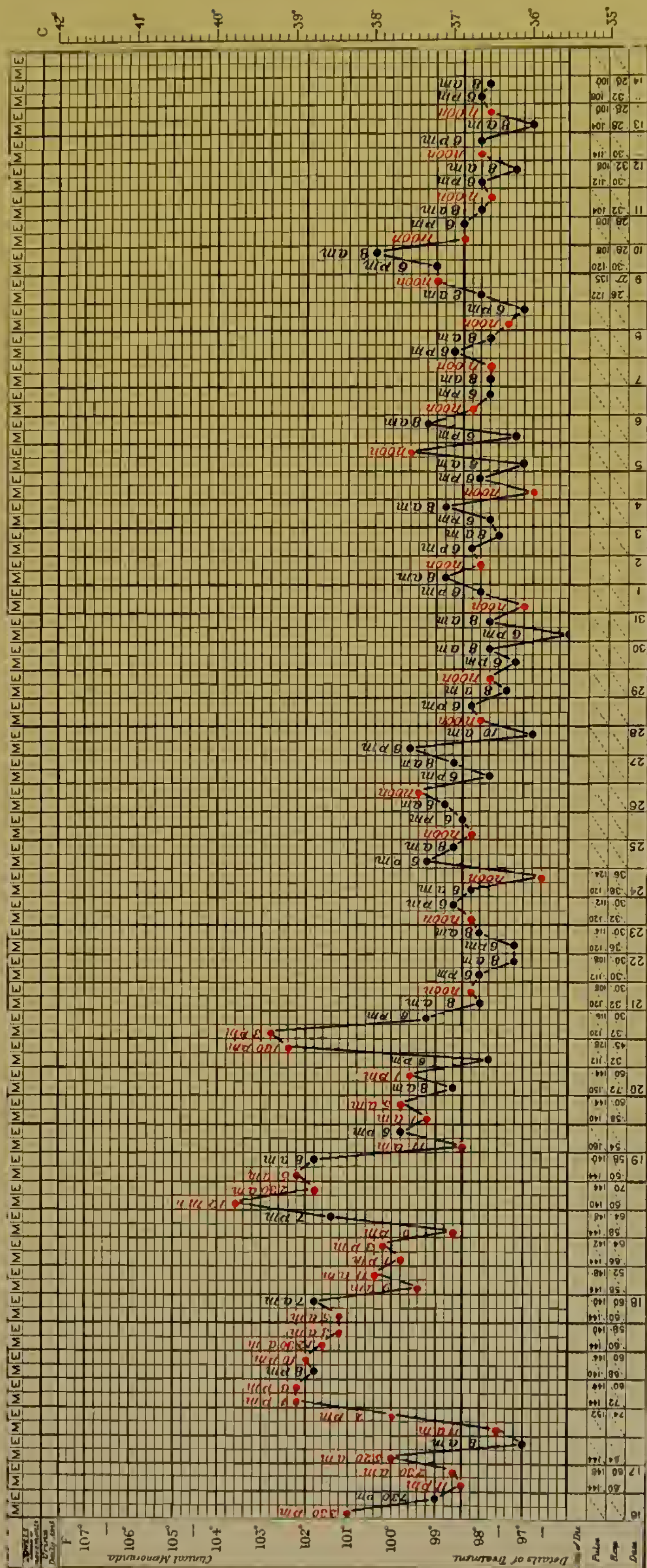
In 21 cases of scarlatina during pregnancy Meyer[177] found it impossible to detect the medium of contagion. The incubation period was from three to five days. In six out of 21 cases the disease ran a mild course without complications. In 8 cases sepsis occurred with two deaths. The resemblance of puerperal scarlatina to diphtheritic infection of wounds was strikingly illustrated in Meyer's complicated cases. The interruption of pregnancy by scarlatina is well illustrated by Remy;[178] abortion occurred at five months, the patient making an uncomplicated recovery.

Variola resembles scarlatina in its infective energy and in its rapid transmission to the fetus. It possesses, however, the fortunate distinction of being susceptible to modification by vaccination. While pregnancy renders the mother more liable to the infection of small-pox, in those cases in which variola occurs in women who have formerly been vaccinated the disease runs a comparatively mild and favorable course. Vaccination during pregnancy is to be performed without hesitation whenever variola is epidemic. Especial care should be exercised in procuring pure virus, and antiseptic precautions are necessary in performing the vaccination. There is abundant reason to believe that the fetus is protected by such vaccination.

Pneumonia during pregnancy is a serious complication for mother and child. The interference with respiration occasioned by the size of the pregnant womb, and the unfavorable conditions under which the heart labors during pregnancy, account in large part for the severity of the complication. Jurgensen, among 2475 women suffering from pneumonia, found 43 who were pregnant. Of this number more than half aborted. As in the other infections, the degree of fever present is of great importance in prognosis. The symptomatology of pneumonia in the pregnant does not differ from that of the disorder in the non-pregnant. It is observed, however, in pregnant patients that embarrassment of the circulation is very often present, and that heart failure develops more rapidly than in the non-pregnant. Mann[179] reports the case of a woman aged forty-two with typical pneumonia at eight months' pregnancy. The fetal heart-sounds ceased five days after the initial chill. Shortly after the crisis of the pneumonia the child was born with the aid of forceps. During labor the patient became cyanotic, and she was allowed to bleed freely from the umbilical cord: although an unfavorable prognosis had been given, the patient made an uninterrupted recovery. The writer reports in this connection the case of a young primigravida aged twenty who developed pneumonia when near the end of gestation. A temperature of 103° F. rapidly developed, and an acute pneumonic process catarrhal in nature was found over both lungs. Although the os was partly dilated, no labor-pains were present. The patient's distress and dyspnea steadily increased, and three days after the beginning of the pneumonia the child was expelled with three or four powerful labor-pains. The child was cyanosed, had fever, and after passing through an attack of pneumonia recovered (Pls. 20, 21).



Fetal pneumonia during pregnancy: chart of the mother.



Fetal pneumonia during pregnancy, with recovery after birth: chart of the infant.

Although the mother's urgent symptoms were relieved temporarily by her labor, she perished of heart failure soon afterward. Examination of her urine during the pneumonia and before her delivery showed the presence of albumin in appreciable quantity, and the proportion of urea was 1.2 per cent. Epithelium from the kidneys, with abundant crystals of oxalates of lime, were found by microscopic examination. The urine contained large quantities of bacteria of various kinds.

The treatment of pneumonia complicating pregnancy is that of the non-pregnant. The patient is in no way improved by the induction of labor, and the occurrence of labor should often be made the occasion for depleting the circulation through controllable post-partum hemorrhage. Pneumonia complicating pregnancy offers more opportunities for depletion than does pneumonia in the non-pregnant woman, and symptoms of threatened asphyxia with profound cyanosis should be met promptly by this resource. Cupping gives great relief in these cases, while the hypodermatic use of strychnia and atropia has proven of comfort to the patient. The complication is serious in proportion to the extent of lung-tissue involved and the tolerance or intolerance displayed by the circulatory apparatus.

The prognosis of pneumonia occurring during pregnancy has been made the subject of study by Wallich,[180] who found that pneumonia interrupts pregnancy in one-third of all cases before the sixth month, and from the sixth to the ninth month in two-thirds of all cases. The maternal mortality varied from 50 to 100 per cent. of recorded cases, while the fetal mortality was 80 per cent.

Cholera during Pregnancy.—Cholera during pregnancy well illustrates the severity of a pronounced infection with the pregnant patient. From a series of 10 cases Klautsch [181] describes two stages of the disease—one attended by copious evacuations from the stomach and intestines, the second by a period of intoxication or asphyxia. The patients were usually taken ill at midnight or early in the morning, and when temporary relief from the symptoms of collapse had been obtained by the injection of saline fluids a typhoid stage frequently developed, with active delirium, followed by deepest coma. During the coma the pulse was strong, dicrotic, and the respiration irregular. Hemorrhage into the conjunctivæ was often present. The fetus usually perished in these cases during the stage of intoxication. The mothers complained that in the first stage of the disease fetal movements were excessively violent. It has been shown by Slaviansky, Tipjakoff, and Simmonds that the epithelium of the placenta is extensively diseased, and that hemorrhages and premature separation often occur. Where the fetus died it was usually expelled at the end of the stage of asphyxia and in the beginning of the typhoid delirium. Instrumental delivery was frequently necessary. Post-partum hemorrhage was rarely observed, and where the mother survived involution often proceeded promptly. As regards the prognosis for the mother, it was as good as the prognosis in cholera in non-pregnant women. For the fetus the prognosis was excessively grave. The treatment of pregnant patients attacked by cholera is the treatment of cholera in the non-pregnant. No attention should be paid to the pregnant condition, other than to complete labor as rapidly as possible when it begins, and to secure good uterine contractions during and after the labor. A more unfavorable view of the prognosis for the mother is given by Galliard.[186] In his cases the lactic-acid method of treatment was extensively employed with negative results. In mild cases a number of his patients recovered.

Tetanus in Pregnancy.—Among the acute infections that attack with great virulence the nervous system of the pregnant patient tetanus is the most formidable. Our knowledge of infection explains by the tetanus bacillus the exciting cause of this complication. A predisposing cause is to be found in the susceptibility which pregnant patients manifest during the first three months of this period. Indeed, the first half of gestation shows by far the greater number of cases of this infection. Tetanus develops usually after some minor manipulation in the early months of pregnancy, and especially where abortion requires interference on the part of the physician. Thus Vinay[182] in 106 cases found but one after craniotomy and one after Cesarean section; the infection is one of early pregnancy, and is not usually connected with parturition at term. Patients most apt to be attacked by the tetanus bacillus are multiparæ above the average age and those who have been living in damp and squalid lodgings. The direct conveyance of the infection has been noted by Henricius and by Amon. The latter, while treating a case of tetanus in the husband, infected the wife, who aborted, during the manual delivery of the placenta. Tetanus is most frequent among pregnant patients in the tropics, where the condition of the soil is favorable to the growth of the infecting germ. An association of tetanus in pregnancy and the puerperal period with endometritis has been pointed out by Markus.[183]

The treatment of tetanus in pregnancy is largely prophylactic. Remembering the peculiar susceptibility of pregnant patients, especially during the first months, any minor operation or examination should be conducted with scrupulous antisepsis. When once tetanus infection has occurred, but little can be done to save the patient.

Tetany is a condition which is commoner during pregnancy than is tetanus. It is characterized by tonic spasms beginning in the muscles of the extremities, especially those of the hands. In severe cases spasmodic movements may extend over the entire muscular system. The spasms are symmetrical when not artificially produced. Attacks of tetany are not accompanied by loss of consciousness. Such seizures are intermittent and of short duration. As a rule, recovery ensues, the spasms gradually becoming less frequent. Patients describe a tingling or a numb sensation of the extremity affected as preceding the spasm, and the same phenomenon follows the cessation of convulsive movements. If the main artery or the nerve of the extremity in which spasmodic movements are observed be compressed, these sensations, followed by spasm, may be induced. The application of cold causes the spasms of tetany to cease. The flexor muscles, and especially the interossei in the hands and feet, are oftenest affected. The electrical reaction of the nerves in the affected region is much increased. The patient's general temperature is not affected. Any mechanical irritation of the peripheral nerves, such as tapping the trunk of the facial nerve in front of the ear, results in spasm. The disorder is generally sporadic and is rarely epidemic. It is most usually observed in women during the childbearing period or during menstruation. Trousseau found, of 44 cases, forty amid nursing women. Kussmaul found transient albuminuria present, and Stiel observed glycosuria. Dakin [184] reports the case of a multigravida of nervous temperament who in the third month of her fourth gestation was seized with frequent vomiting during the day. After this condition had persisted for eleven days she developed spasm of various muscles, preceded by numbness. The hands and feet assumed the posture seen in tetany, the flexors in contraction, and the interossei producing extension of the phalanges. The soles of the feet were hollowed by spasmodic extension. The affected muscles were slightly painful. The condition extended to all the extremities, and vomiting was increased. On the second day of tetany the spasmodic condition became so excessive as to cause intense suffering. The temperature was subnormal. The patient died of asphyxia produced by spasm of the muscles of respiration on the third day of the tetany. Trousseau recognizes three varieties of tetany in accordance with the severity of the affection. He rarely observed a fatal result. Meinert saw five cases end in recovery. In one of these cases the patient suffered from tetany in successive pregnancies. One of Meinert's patients had her thyroid gland removed. Between the attacks of tetany the patient is normal to all appearances. In non-fatal cases the pregnancy is not interrupted nor is labor influenced, the spasms ceasing as soon as the uterus is emptied or within a few days.

In contrasting tetanus with tetany in pregnant patients it is well to remember that in tetanus the spasm begins in the face or the neck, and advances centrifugally with opisthotonos. In tetany the spasm begins in the extremity and advances centripetally, producing the characteristic posture of the extremities. In tetanus the spasm is constant: in tetany it is intermittent. The great fatality of tetanus and the comparative mildness of tetany are to be kept in mind. Tetanus is commonest among men, who by virtue of their occupations are exposed to infection from the tetanus bacillus. Tetany is peculiarly common among pregnant women or women in a depressed and susceptible condition. The differential diagnosis between the convulsions of toxemia and those of tetany is not difficult with accurate observation.

The treatment of tetany in pregnancy consists in giving the patient such sedatives and anodynes as shall procure sleep. Vomiting or diarrhea requires especial attention, as it induces a condition of debility favoring a fatal issue. Abortion should not be produced in tetany, as the disorder rarely fails to yield before intelligent medication.

4. Accidents and Surgical Operations during Pregnancy.

Although the nervous system of the pregnant woman is remarkably susceptible in many ways to reflexes, she sometimes exhibits a very decided power of tolerance to severe injury or to surgical interference. The difference in this resisting power, as shown by some patients and as seen to be lacking in others, depends not only upon the condition of the nervous system in these cases, but also upon the normal or abnormal state of the uterus and its lining membrane. In a woman in perfect health a considerable injury or a surgical shock may be received without the interruption of pregnancy, while if the patient is of extraordinarily susceptible nervous system or if the endometrium is in a condition of disease, interruption of pregnancy is almost inevitable. Accompanying the premature ending of gestation serious hemorrhage, shock, and greatly increased susceptibility to septic infection are observed.

Those operations most frequently demanded during pregnancy are surgical procedures undertaken for some condition of the uterus or of its appendages. Thus cancer of the uterus demands the complete extirpation of that organ as soon as the diagnosis is made, irrespective of the existence or the period of gestation. One of two methods of operation may be chosen—extirpation *per vaginam* when the diseased uterus is small, or the complete removal of that organ through the abdominal cavity when its size precludes the possibility of its removal through the vagina. In either instance the prognosis for the recovery of the mother is by no means desperate if the operation be performed before her strength has been reduced by the development of cancerous cachexia. It is sometimes possible to combine the two methods of operation, as in an interesting case reported by Stocker,[185] in which a multigravida was found to have cancer of the cervix. At the sixth month of pregnancy the cervix was removed *per vaginam*, and the complete extirpation of the uterus was accomplished by opening the abdominal cavity. The patient made a good recovery from the operation.

Myomotomy and *myomectomy* are demanded during pregnancy for fibroid tumors complicating the development of the pregnant uterus. The choice of operation will depend upon the size and location of the tumor, and upon the amount of pressure which it is exercising or which it will cause upon the growing womb. Flaischlen[186] found two fibroid tumors behind the uterus in the case of a patient pregnant three months; one tumor sprang from the cornu of the uterus, the other from the base of the womb. Both tumors were ligated and removed without the interruption of pregnancy.

Amputation of the pregnant womb is a familiar operation for contracted pelvis. It may, however, be performed at any period of gestation when the interests of the patient demand hysterectomy. The method of procedure best adapted to such cases is abdominal incision, ligation of the ovarian and uterine arteries, and amputation of the uterus, leaving a short stump to close the vagina and stitching the peritoneum over the surface of the stump.

Tumors of the ovary are justly considered serious complications of pregnancy. Dsirne[187] collected 135 cases in which pregnancy was complicated by tumor of the ovary. He finds that the gravity of this complication increases as pregnancy advances. There is rarely any reason in this complication for delay in removing such a tumor by abdominal incision. Puncture of an ovarian cyst and the artificial interruption of pregnancy are to be avoided: they are to be considered only in the light of procedures adapted to an unforeseen emergency. The preferable time for operation in such cases is before the fourth month of gestation. The fetus is least likely to be lost when operation is performed in the third or the fourth month. No period of pregnancy, however, contra-indicates ovariotomy, but this complication uniformly demands operative treatment. Double ovariotomy during pregnancy may be successfully performed, as exemplified by Polaillon.[188] His patient, aged twenty-three, had a good-sized ovarian cyst upon one side and a diseased ovary upon the other side. Her general condition at the time of operation was not promising, and numerous adhesions complicated the removal of the tumor. Operation was performed in the third month of gestation, and it resulted in the continuance of pregnancy, which terminated in normal delivery with a healthy child. The patient's pulse and temperature showed little reaction following operation. Kreutzman[189] reports two cases in which ovarian tumors were successfully removed from pregnant patients without interrupting gestation. One of these women, who was in her second pregnancy, had gone two weeks over time. She had a large ovarian cyst in the left ovary, the pedicle of which had recently become twisted, the contents of the tumor being tinged with blood.

Affections of the Fallopian tubes may call for operative interference during pregnancy. The prognosis in these cases is equally good with that of operation for the removal of ovarian tumors, and the reasons for prompt interference are quite as cogent as in the former case. In hematosalpinx it is often impossible to make a differential diagnosis between this condition and ectopic gestation. This fact is well illustrated in the experience of Doran,[190] who removed both tubes and ovaries from a patient who had suffered from attacks of violent pelvic pain at various intervals. One tube had ruptured, allowing the free escape of blood; the tube contained a structure in the midst of a clot resembling an aborted ovum. It is probable that double ectopic gestation existed. The patient made an uninterrupted recovery.

Accidents and Injuries.—As regards tolerance to general accidents and injuries during pregnancy, American observers have noted the remarkable tolerance displayed by negro women under such circumstances. Thus, Tiffany[191] reports the case of a negro woman who fell, striking the abdomen violently against the edge of a tub. Peritonitis with retention of urine followed. The patient, however, under faithful attendance recovered without the interruption of pregnancy. Stab-wounds of the abdomen occurring during the pregnant period, but without interrupting gestation, are reported by Belin,[192] in whose patient a considerable portion of the epiploön protruded from the wound. Sloughing ensued, but the patient made a good recovery.

Richard[193] describes the case of a pregnant woman who fell, lacerating the abdominal wall near the umbilicus. A mass of intestine protruded as large as a man's head. The woman was at term, and soon after normal labor ensued, from which the patient recovered. Harris[194] describes the case of a woman pregnant six months whose abdomen was torn open by the horn of a bull. Although omentum and intestine protruded, pregnancy was uninterrupted. The viscera were replaced and the wound was closed by suture. A similar case in which a lacerated wound of the abdominal wall 5 inches long was made is reported by Corey.[195] In this case the pregnancy was at the third month. The patient went two hundred and two days longer in gestation, and had a normal labor. Obstruction of the intestine calling for abdominal section is described by Rydygier,[196] who operated in the sixth month of gestation upon a patient who had symptoms of strangulation for seven days. Recovery without abortion ensued.

In fractures retarded union is reported by Petit[197] and others in pregnant women sustaining this accident.

An interesting operation for stone in the bladder upon a patient eight months pregnant is reported by Keelan.[198] The calculus, which weighed 12½ ounces, was successfully removed without the interruption of pregnancy.

Gunshot wounds not penetrating the uterus do not commonly interrupt gestation. A remarkable instance is cited by Prozowsky.[199] The patient was wounded in many places by pieces of lead pipe fired from a gun but a few feet distant. Neither she nor her child suffered, so far as gestation was concerned, from the accident. A pistol-shot wound of the lung occurring during pregnancy, followed by hemorrhage and shock, is reported by Bancroft.[200] A healthy child was born at term.

A remarkable case is described by Lihotzky,[201] which illustrates the fact that the changes occurring in pregnancy may bring into active irritation a foreign body that had previously been inert; he describes the case of a patient perishing from rapid peritonitis in the eighth month of pregnancy. At the autopsy the duodenum was found perforated by a spoon which the patient had swallowed two and a half years previously—an occurrence almost forgotten.

The remarkable tolerance shown by the pregnant woman to direct injury from mechanical causes is illustrated in a case reported by Milner.[202] The woman in the sixth month of pregnancy was accidentally shot through the abdominal cavity and the lower part of the thorax, the missile penetrating the central tendon of the diaphragm and lodging in the lung. Localized pneumonia and peritonitis seemed to limit the injury, the wound draining through the lungs by very free expectoration. Recovery ensued, the patient giving birth to a healthy child sixteen weeks later.

Direct mechanical injury may rupture the pregnant uterus, usually causing the death of the patient. It is interesting to observe that the membranes may remain unruptured in these cases, thus obscuring the diagnosis of rupture of the womb. Neugebauer[203] describes a case of suicide in which a primigravida threw herself from the third story of a house upon a stone pavement;

the immediate cause of death was fracture of the skull. The uterus ruptured, and the fetus in its unbroken membranes was found among the mother's intestines. The patient's pelvis also sustained serious injury.

That pregnant women can endure terrible injury complicated by erysipelas, and still go on to term, is illustrated by a case reported in the *Prager medicinische Wochenschrift*, 1881, No. 6. A woman in the eighth month of pregnancy, while working in a brickyard, was buried beneath a mass of earth and rock. A terrible gash was cut through the scalp, and many bruises and lacerated wounds were sustained. Erysipelas attacked the wounds of the scalp, and the patient was for a time very ill. She did not, however, miscarry, but bore a healthy child at term. Fancon [204] describes the case of a woman who had an injury to the knee requiring drainage. She was attacked by erysipelas, which spread over the whole body save the genital organs and the head and neck. Her pregnancy was uninterrupted and recovery ensued.

Operations upon the rectum are to be avoided if possible in pregnant patients. It has been shown by Tiffany [205] that such operations are an exception to the rule in usually producing abortion or miscarriage. On the contrary, a diseased kidney may be removed from a pregnant patient, as shown by Tiffany, [206] with complete success.

While major operations seem well borne by pregnant women, minor surgical procedures of an irritant character are sometimes attended by disastrous results. Thus, Fancon observed in the clinic at Strasburg a case where cauterization over the ankle-joint was practised for a neglected sprain. Abortion followed, complicated by septic infection, necessitating amputation. The patient finally succumbed. Pregnant women often survive burns without the interruption of gestation if the pregnancy is not far advanced and the burn is not severe. Hunt [207] reports a case of excessive burn in the ninth month of pregnancy that seems to have affected the fetus directly, for the child was born dead and blistered over an area corresponding with the burns upon its mother's body. Curiously enough, cases are reported where pregnant women have suffered from abscess of the breast, in which the abscess has been opened, curetted, and drained without interrupting pregnancy, although interfering with the breasts usually results in profound disturbance of the uterus. Pregnancy is no contra-indication to excision of the cancerous breast, as illustrated in a case reported by Pilcher.[208] Parasitic growths of the abdominal cavity requiring abdominal section have been treated by surgical interference during pregnancy with success. Amputation for crushing injury and severe blows has been sustained by pregnant patients, and recovery ensued. A remarkable case is reported by Fancon, in which a pregnant woman jumped from a second-story window without interrupting the gestation. Amputation at the hip-joint during pregnancy has been successfully performed by Keen.[209] The reason for operating was malignant disease of the femur. The patient, who was five months pregnant, had been living in the tropics. She made a good recovery after the operation, without symptoms of abortion during her convalescence.

In deciding upon operations upon pregnant patients care should be taken that the various excretory organs of the body be placed in the best possible condition. All unnecessary shock is carefully to be avoided, as is also hemorrhage. Although a hemorrhage does not seem to produce abortion, it is dangerous, because it renders the patient more susceptible to septic infection. Fractures unite poorly in pregnant patients, and application of cauterizing agents should not be practised during pregnancy. Major operations on the abdominal contents are especially well borne. Pregnancy does not contra-indicate operation for diseased conditions of the uterus, the tubes, or the ovaries, provided the fetal sac is not opened.

A striking instance of the benefit which pregnant patients sometimes receive from operative interference is shown by those cases of osteomalacia during pregnancy greatly benefited by oöphorectomy. A good example of this is the case described by Rasch :[210] the patient, a multigravida, aged forty-one years, suffered from osteomalacia, which continued after the birth of her twins. As the condition continued to grow worse, the tubes and ovaries were removed, when the patient began immediately to improve, and subsequently became able to walk.

The almost incredible power of resistance which the pregnant uterus displays to interference is well illustrated by a case reported by Vickery :[211] this patient was subjected to medication and operative interference to empty the uterus ; it was supposed that incomplete abortion occurred, and her physician curetted the uterus and applied tincture of iodin followed by injections of hot water. Notwithstanding this treatment pregnancy continued.

The *prognosis* of pregnancy complicated by tumors in cases subjected to operation must be considered as decidedly favorable. Gerdes[212] gives an interesting account of 16 cases of pregnancy complicated by abdominal tumors ; out of the 16 cases, four perished : all the cases were treated by operation, and many of them in the most radical manner.

5. Diseases of the Ovum.

Under Diseases of the Ovum will be included the disorders of the membranes, the deciduæ, the placenta, and the funis. The following syllabus presents the topics taken up for consideration in their expressed order :

Amnion :	Adhesions and bands, Polyhydramnios, Oligohydramnios.	Placenta :	Placentitis, Calcareous degeneration, Fatty degeneration, Apoplexy, Tumors, Syphilis. Anomalies in position, size, weight, shape, and number.
Chorion :	Vesicular mole or Myxoma.		
Decidual endometritis :	Polypoid, Hypertrophic, Cystic, Catarrhal.	Cord :	Coils, Knots, Torsions, Stenosis of its vessels.

A. Diseases of the Amnion.

Amniotic Adhesions and Bands.—Adhesions between the fetus and the amnion, supposed to arise from an arrest of development, are occasionally met with. As the amniotic fluid increases the adhesions are elongated, forming bands. They cause certain deformities, as webbed toes and fingers. Rarely, an amputation of a fetal limb results. When the bands and adhesions are accompanied by a deficiency of the amniotic fluid (oligohydramnios), they are regarded as the cause of malformations of the lower extremities, because the fetus cannot preserve its normal attitude, and it is therefore subjected to injurious compression, resulting in deformities.

Polyhydramnios, or dropsy of the amnion, is an excess of the amniotic fluid. When this fluid is in marked excess of two quarts, polyhydramnios may be said to be present. Cases are recorded where more than twenty quarts existed. This condition is found more frequently in multiparæ than in primiparæ—23 to 5; more frequently in twin pregnancies of the same sex than in single pregnancies. In some cases of twins one sac contains an excess of fluid, while the other sac contains less than the usual amount. This condition has been found in extra-uterine pregnancy.

Two forms of polyhydramnios have been described, the *acute* and the *chronic.* In the former the accumulation of the fluid is very rapid, producing fever. In the latter the fluid increases slowly, and the uterus thereby tolerates its pressure to a greater extent. This condition is sometimes dangerous, because the centrifugal pressure conduces to a critical tensity of the uterine walls, threatening rupture. In labor the sudden free exit of the fluid favors malposition of the fetus, and especially prolapse of the umbilical cord.

Pathology.—The pathology of polyhydramnios is most obscure. This disease has been attributed to a defective maternal cardiac action, permitting transudation of serum from the maternal blood through the fetal membranes. Inflammation of the amnion (amniotitis) has been held as a cause. To great activity of the renal function of the fetus it has also been attributed. There is no settled opinion at present as to its causation. A recent author states that there is a frequent and an undeniable connection between polyhydramnios and the insertion of the placenta in the inferior part of the uterus. The blood-stasis resulting from such a low insertion favors osmosis into the amniotic cavity.

Symptomatology.—The unnaturally rapid increase in the size of the uterus is the most striking symptom of polyhydramnios. The uterus at five months becomes as large as it should be at term. Fluctuation becomes a conspicuous symptom, even to the point of utterly obscuring the presence of pregnancy. Obstetric auscultation and palpation are easily rendered nugatory. Pressure-symptoms relating to circulation and to respiration become especially urgent. Vaginal examination reveals a nearly or quite obliterated cervix and a resilient mass filling entirely the pelvic inlet.

Treatment.—Induction of labor is demanded in the acute form, but in the chronic form only when the pressure-symptoms become urgent. It has been recommended to cautiously draw off the excess of fluid with an aspirator. Two things must be guarded against: first, the malposition of the fetus and precipitate labor; second, a post-partum hemorrhage, which is so liable to result from uterine atony after over-distention.

Oligohydramnios means a deficiency of the amniotic liquid. Its pathology is unknown. Adhesions and bands are frequent in this condition. It cannot be detected prior to delivery; it is revealed at that time only. Fetal malformations are frequently encountered in oligohydramnios. The fetus is subjected to an abnormal pressure which results in deformities. Webbed toes and fingers are alleged to arise from this condition. Amputation of a fetal extremity may follow the abnormal deficiency of fluid. Malformations of the inferior extremities are ascribed to this complication.

B. Diseases of the Chorion.

Vesicular Mole (Cystic mole; Hydatidiform degeneration of the chorionic villi; Dropsy of the villi of the chorion; Myxoma of the placenta; Molar pregnancy).—The villi of the chorion occasionally undergo myxomatous degeneration, which produces a vesicular mole. The mole is a mass of pedunculated vesicles resembling in appearance grapes or gooseberries. There may be as many as five or six thousand of such vesicles. The vesicles vary in size from a millet-seed to that of a filbert, and they contain a fluid, usually colorless, transparent, liquid as water, holding albumin in solution. Rarely the fluid is reddish in color. If all the villi of the chorion are involved in the degeneration, the life of the ovum is always sacrificed. If only a small portion of the villi are involved, the life of the ovum is not necessarily destroyed and development to term may proceed. In twin pregnancies one chorion may undergo myxomatous degeneration while the other ovum may proceed to full development and be born at term. Often in double pregnancy the development of a cystic mole in one chorion seriously compromises the life of the other ovum, resulting in a miscarriage. Vesicular mole is very rare. One author reports only one case in over twenty thousand deliveries. It is oftenest found in multiparæ of from twenty-five to forty years of age. Numerous recorded cases of women who have repeatedly developed vesicular moles exist; one case developed this condition in eleven pregnancies.

Pathology.—An endometritis is generally supposed to be the factor predisposing to the development of a molar pregnancy. The villi of the chorion undergo hypertrophy and myxomatous degeneration. Three cases have been reported wherein the chorionic villi grew so rapidly as to penetrate the uterine wall even to the peritoneal covering, rendering successful removal impossible without a fatal hemorrhage or a subsequently fatal peritonitis.

Symptomatology.—Three symptoms characterize molar pregnancy: first, an abnormally rapid increase in the size of the abdomen; second, uterine hemorrhage; and third, the expulsion *per vaginam* of the vesicles of the mole.

It may be possible to feel the grape-like masses through the cervical canal. Exsanguination of the patient and septic infection are the chief dangers. As a rule the fetus dies. Rarely, a bunch of the vesicles may be expelled without the course of the pregnancy being interrupted.

Treatment.—No active interference is demanded until the hemorrhages occur. If they are small, rest and an opiate may suffice. If severe, the uterus must be dilated and very carefully curetted, subsequent hemorrhage being prevented by an intra-uterine tampon. The possibility of the growth having penetrated and thinned the uterine wall makes it necessary to use the curette cautiously to prevent perforation of the uterus.

C. Decidual Endometritis.

One of the commonest diseases of the ovum is *decidual endometritis.* Four varieties of this disease are described to-day: the polypoid, the hypertrophic, the cystic, and the catarrhal. The names of the different varieties indicate the predominating characteristic of the endometritis. In catarrhal endometritis the discharge of a watery fluid is so abundant as to receive the name *hydrorrhea gravidarum.* It may occur as early as the third month, but usually it is not encountered until the last months of pregnancy. It is more frequently seen in multiparæ than in primiparæ. It is found upon close observation to be a mucous secretion rather than the yellowish amniotic fluid; the latter is further differentiated by containing urea. The sudden appearance of the fluid in a large quantity is generally mistaken for premature rupture of the membranes. In most instances it is repeated several times before delivery occurs. Should pains follow, quietude and an opiate are indicated.

The etiology of hydrorrhea gravidarum is obscure. It has been attributed to syphilis, to overwork, to an exaggeration of a pre-existing endometrial inflammation, to gonorrhea, and to an infection following the death of the ovum, to be followed sooner or later by a miscarriage. The frequency of miscarriage from an old endometritis is a well-known fact in obstetric observations.

The treatment of this malady during pregnancy is absolutely *nil.* All that can be done for it must be done in the intervals between gestations.

D. Diseases of the Placenta.

Placentitis, inflammation of the placenta, is a very rare disease. Its origin is very obscure, but it is supposed to start from the decidual tissue or from the larger fetal arteries. It soon terminates in induration, oftentimes resulting in strong adhesions between the placenta and the uterine wall, constituting the *adherent placenta.* Apoplectic infarcts are often found in placentitis.

Calcareous Degeneration (Placental calculi; Ossiform concretions; Placental ossification).—By this term is meant the deposits of lime on the edges of the cotyledons or in their substance in the shape of particles of sand or of needles or of scales. They consist of amorphous carbonates and phosphates of lime and magnesia. The presence of these secretions is without therapeutic significance, and has no ill effect on the functions of the placenta; so many as five hundred have been found in one placenta.

Fatty Degeneration.—A fibrous, followed by a fatty, degeneration of placental villi is of very common occurrence, especially toward the margin of the placenta. When it involves a small area no serious interruption of the function of the placenta follows. When a large area is involved the death of the fetus occurs. The *etiology* of this condition is unknown. A fibrous degeneration, undoubtedly the condition denominated by the earlier writers "aclerases," or "scirrhous" or "cartilaginous degeneration" is regarded as the precursor of fatty degeneration, because it diminishes the blood-supply, which leads directly to fatty degeneration, or, in some cases, to amyloid degeneration. The *diagnosis* of this condition is quite impossible during pregnancy.

Apoplexy.—Blood escaped from a ruptured blood-vessel and occupying circumscribed cavities formed in the tissue of the placenta is called "placental apoplexy." It is occasioned, as a rule, by the rupture of some of the maternal blood-vessels. The effused blood rarely comes from the placental vessels. The clots vary in size from that of a millet- or a hemp-seed to that of a pigeon egg. Usually there are several clots, a large number being twenty or more. They are situated at various depths in the substance of the placenta, from the fetal to the uterine surface, upon which some of them have a small and irregular orifice. Owing to the spongy nature of the substance of the placenta, the normal condition of the tissue is disturbed only a few lines from the boundary of the cavities. The effused blood soon separates into two parts, one solid, the other liquid. The serum disappears by osmosis, while the solid part contracts, becomes denser and smaller, and loses its color. These whitish homogeneous masses have been denominated concrete pus or tuberculous matter. Cutting into the cotyledons of a placenta often reveals apoplectic clots in the various stages of chronological consecutive changes.

The results of placental apoplexies depend upon the period of gestation in which the hemorrhages occur, and upon their number and the extent of territory invaded. Abortion or premature labor is rarely produced. If the infarcts are small and few in number, the gestation will be completed and the fetus will continue to live, its nutrition suffering little or not at all. If, however, the effusions are large and numerous, the offspring will be born feeble, puny, and emaciated. If the apoplectic attacks recur at short intervals, there will occur a progressive diminution of fetal motions and heart-pulsations until they cease altogether. In all cases of a dead-born fetus placental apoplectic infarcts should be sought after carefully. It is by no means rare that women miscarry repeatedly from this cause, and when they do complete their gestations their placentas will be found to contain a number of effusions, both old and recent.

Symptoms and Treatment.—The occurrence of placental apoplectic infarcts rarely betrays itself by any recognized symptoms, provided the hemorrhage is limited in amount. In some cases there may be present indications of internal hemorrhage, whose occurrence will be suspected, chiefly in women who have experienced this condition in previous gestations and in whom placental apoplexy was found. Should placental apoplexy be suspected, especially in women predisposed to the affection, the prophylactic treatment of uterine hemorrhage is indicated. Absolute rest, small phlebotomies, and saline cathartics, repeated *pro re nata*, are the most rational treatments.

Tumors.—Both solid and cystic tumors of the placenta have been described. They are very rare. They may originate in the meshes of the cellular tissue or in the glandular cavities of the decidua serotina. Solid tumors may cause death and expulsion of the fetus, while the placenta may remain for weeks and even months before being expelled. The presence of tumors can be determined only after delivery, for there are no known symptoms indicating their presence.

Syphilis.—Syphilis of the placenta is a well-established condition. The observations of Fränkel are classic, and comprise all that is fully settled, to-day, upon this subject. The appearances of the placenta with syphilis derived from the father differ from those of the placenta with syphilis derived from the mother. In the former the fetus is diseased and the villi are filled with fatty granulations, their vessels are obliterated, and their epithelial coverings are thickened or absent. In the latter there may be present one of three conditions, which vary according to the time of infection:

1. If the mother be infected during the generative act at the same time as the fetus, syphilitic foci will often develop in the maternal placenta (placental endometritis).

2. If the mother is syphilitic before conception or becomes so shortly after, the chances of the placenta remaining healthy are about even.

3. If the mother is not infected until after the seventh month of pregnancy, both fetus and placenta escape entirely.

A syphilitic placenta is heavier, larger, and paler than normal. Its general color is pale red, but in its diseased parts it is yellowish-white. Here and there the tissue is firmer, more resistant, compact, and friable than normal placental tissue.

Anomalies of the Placenta.—The more important anomalies of the placenta are anomalies in *position*, *size*, *weight*, *shape*, and *number*. At the end of pregnancy the placenta is normally situated at the fundus of the uterus, anteriorly or posteriorly; it is from 2 to 3 centimeters (1 inch) thick at its central portion and from 17 to 18 centimeters (7 inches) in diameter. It weighs about one pound.

The abnormal position of the placenta of greatest clinical importance is placenta prævia, by which is understood a situation of the placenta in any portion of the lower uterine segment—that is, in that portion of the uterine body which is dilated during the progress of labor.

The size of the placenta is exceedingly variable; sometimes it is very thin and correspondingly large. This abnormality is most remarkably exhibited in the so-called "placenta membranacea," a placenta formed by the hypertrophy of the entire chorion, the normal atrophy of the chorion leve not occurring. The placenta is frequently enlarged by edema when there is dropsy of the amnion from either local or general causes. An increase in weight of the placenta usually, although not always, accompanies an increase in size.

The variations in shape are of interest, and the anomalies of number are of great clinical importance. The shape is usually round; it may be very irregular, one or more lobes being more or less developed, when the names placenta duplex, tripartita, multiloba, etc. are applied (Pl. 22, Figs. 1–3); it may be oval, as is quite frequent in the so-called "battledore placenta" (Pl. 22, Fig. 6); it may have a horse-shoe or crescentic shape.

The anomalies of number are of greater clinical importance than the variations in size and shape. The danger of accessory growths lies in the possibility of one or more of these growths being retained in the uterus and undergoing decomposition with the production of septic infection. When these accessory placental growths serve as a channel of communication between the blood-sinuses of the decidua and the main placental growth—in other words, when they are functionally active in carrying nutriment to the growing fetus—they are called "placentæ succenturiatæ" (Pl. 22, Figs. 4, 5). Placentæ spuriæ are analogous accessory formations whose villi have no direct communication with the maternal blood.

E. Anomalies of the Cord.

Coils.—One or more coils of the funis may be around the body of the child or around one or more of its members. The neck is the part most commonly encircled. As many as eight coils around the neck have been reported. They are found more often with male than with female children. They occur more frequently in multiparæ than in primiparæ. Their injurious effect is to produce sufficient constriction of the vessels to result in fetal death.

In cases where the coil passes over the portion of the fetus lying against the anterior wall its presence can sometimes at least be inferred by the detection in it of a murmur which is synchronous with the fetal heart-sound. A positive diagnosis cannot be established before labor.

Coils are found at least once in five or six deliveries. In breech presentations and when around the neck they are the most dangerous to the child. Cases of amputation of the members by the pressure of the cord coils have been reported, but it is generally thought that these amputations result from amniotic bands rather than from coils of the cord.

Knots.—When the cord is abnormally long or the liquor amnii very abundant, knots in the cord are liable to be found. They may be double or be single. One case is reported where five knots were found. In recent knots the Whartonian jelly is not displaced, the cord diameter being normal. In old knots the jelly is displaced, and the diameter of the cord is decidedly lessened in the knot. Ordinarily the circulation in the cord is not molested,

ANOMALIES OF THE PLACENTA: 1. Placenta with irregular lobes (Auvard). 2. Placenta in two unequal lobes (Auvard). 3. Irregular placenta (Auvard). 4. Small accessory placenta (Ribemont-Lepage). 5. Placenta succenturiata (Ribemont-Lepage). 6. "Battledore" placenta, oval (Auvard). 7. Placenta with velamentous attachment of cord (Ribemont-Lepage). 8. Placenta with two equal lobes (Ribemont-Lepage).

but occasionally the knot is so tightly drawn as to cause fatal fetal asphyxia. One case of twins is reported where a hard square knot that united both cords was found, resulting in the loss of both children.

Torsions.—In the vast majority of cases the cord is twisted upon itself from left to right; the cause is unknown. Torsions are likely to be very numerous when fetal death has occurred several days before delivery, are commoner in male than in female children, and are most numerous near the two extremities of the cord. In some cases the jelly of Wharton is wanting at the twisted points, and the life of the infant is endangered from embarrassment of circulation. Complete atresia of the cord and death of the fetus may follow.

Stenosis.—Independently of knots and torsions, narrowing of the vessels of the cord may occur, usually in the vein near the placenta. The causes of these stenoses are believed to be syphilis and atheromatous degeneration. But one eventuation succeeds the development of such stenosis, and that is the death of the fetus.

6. Abortion.

Definition.—In a general sense by "abortion" is meant the interruption and termination of pregnancy by the expulsion of the ovum before the end of the twenty-eighth week, or the seventh lunar month of gestation. In a more restricted sense the term is used to denote the expulsion of the ovum prior to the complete formation of the placenta—that is, before the end of the twelfth week, or the third lunar month—"miscarriage" being the term applied to expulsion of the ovum from the twelfth to the twenty-eighth week. Expulsion of the fetus between the twenty-eighth week and a short period before full term is designated "premature labor." A goodly number of cases are recorded where fetuses have been born alive between the fourth and seventh lunar months, the greater number living a few hours only, while several six months' fetuses lived and were successfully reared.

Another classification of abortion sometimes used is that which divides the subject into "ovular abortion," occurring before the twentieth day, "embryonic abortion," occurring between the twentieth and the ninetieth day, and "fetal abortion," occurring between the twelfth and the twenty-eighth week.

Frequency.—Statistics as to the frequency of abortion are necessarily incomplete, and therefore unsatisfactory. Very many abortions take place, especially during the first three months of pregnancy, that do not come to the knowledge of the physician, and it is fair to presume that prior to the third month an immense number occur which are not even suspected by the patients themselves. The actual number of abortions, therefore, must largely be in excess of estimates based upon statistics of observed cases. The relative frequency of abortion to labor at term has been estimated variously by different authors as 1 : 5½ and 1 : 8, while the relation based upon hospital statistics has been placed at from 1 : 75 to 1 : 80. According to some investigators, from thirty-five to forty out of one hundred mothers, to their own knowledge, have aborted at least once before their thirtieth year.

Time of Occurrence.—Abortions occur most frequently during the first, second, and third months of pregnancy, when the ovum is usually thrown off *in toto*. The throwing off of the ovum so frequently at this period is due in part to the great vascularity of the uterine mucous membrane at this time, in part to the feeble attachment of the undeveloped chorionic villi to the decidua, in part to the space existing between the chorion and the decidua reflexa (this latter allowing of the easy accumulation of blood between the membranes), as well as to the inability of the ovum at this early stage to offer sufficient resistance to disease-processes. The changes incidental to placenta-formation is no doubt also an important factor in the production of abortion at the third and fourth months. Abortion is more apt to take place upon the days corresponding with the menstrual periods. The disposition to abortion diminishes after the fourth month, as the placenta becomes more fully developed and the connection between the ovum and uterus becomes stronger, and the uterus adjusts itself to the new order of things.

Etiology.—Abortion is the direct result either of fetal death or of uterine contractions. The causes which result in fetal death or in uterine contractions are usually subdivided into those referable to the *father*, to the *mother*, or to the *fetus*, and may be either *predisposing* or *exciting*.

Exciting causes, either alone or in connection with some predisposition, act quickly and more directly upon the uterus or the ovum. Such are violent coitus, blows, falls, contusions, the jarring of railroad travel, missteps, running of a sewing-machine, lifting of heavy weights, rapid stair-climbing, sea-bathing, stretching of the arms above the head, etc. Abortion produced for therapeutical purposes will be treated of in another section.

Exciting causes are generally only active in the presence of the predisposing ones, while many of the predisposing causes remain inactive except in connection with some exciting cause. We cannot, as a rule, say in a given case what will and what will not produce abortion, for on the one hand there are many notable instances where pregnancy has been terminated prematurely by the mildest of exciting causes in the apparent absence of any predisposition, and on the other hand where the most serious traumatisms in the presence of a demonstrable predisposition has failed to produce abortion.

Paternal Causes.—A syphilitic father may produce syphilis in the ovum without necessarily infecting the mother. Other causes on the part of the father are extreme youth and old age, debauchery, and feebleness.

Maternal Causes.—Systemic, recurrent, or so-called "habit" abortion is probably due not so much to a maternal constitutional predisposition, the result of habit, as was once believed, as to a continuance of the original cause. *Tuberculosis* and *syphilis* of the mother may destroy the fetus by transmission of these diseases either to the placenta or to the ovum, or simply by lowering the mother's vitality. Syphilis is responsible for most recurrent abortions. The *acute infectious diseases* kill the fetus either by the direct action of the poison transmitted through the placenta, by the action of high temperature, or by the tendency to placental hemorrhage produced by the disease-process. Diseases of the *heart, lungs, liver,* and *kidneys* destroy the fetus by producing passive congestions in the placenta.

An excess of carbonic acid gas; chronic lead-poisoning; convulsive diseases, such as chorea, eclampsia, epilepsy; excessive vomiting and coughing; an irritable nervous organization and the habits associated with the extremes of social life; excessive physical exertion, fright, anxiety, and other emotional excitements,—are all more or less potent factors in the causation of abortion. Hot sitz- and foot-baths tend to produce abortion by dilating the pelvic blood-vessels, in this way causing an excessive amount of blood to be sent to the uterus.

Among the local causes may specially be mentioned subinvolution, acute and chronic inflammatory diseases of the uterus and its appendages, as well as tumors, displacements, adhesions, and degenerations. *Endometritis* and *retroflexion* are particularly prone to act as inciters of uterine contractions. Adhesions of the uterus to adjoining organs, as well as tumors of the uterus and in its vicinity, contracted pelvis, and tight-lacing, occasionally cause fetal death by impeding the development of the uterus. While *surgical operations* of the most serious nature have been performed on the uterus and other pelvic organs during pregnancy without in any way influencing the ovum, operations of a minor kind upon distant organs have produced abortion.

Fetal Causes.—Any morbid condition of the ovum or its appendages that endangers the life of the fetus is liable to bring about premature expulsion of the fetus. Syphilitic disease of the membranes and the placenta is a frequent cause. Among other causes may be mentioned hydrorrhea, cystic degeneration of the chorionic villi, placental apoplexy, and the various degenerations of the placenta; abnormal relations of placenta, especially placenta prævia; too short a cord and the knotting of the cord. Death of the fetus may be brought about by disease transmitted from or through the mother, such as syphilis, small-pox, and other infectious diseases, and rarely tuberculosis.

Pathology.—Hemorrhage from rupture of the utero-placental vessels usually takes place in the decidua vera, but the blood is often forced between the decidua and the chorion. Occasionally hemorrhage breaks through the decidua, and even through the amnion and into the amniotic cavity, filling the sac with blood. Uterine contractions separate the chorionic villi from the decidua reflexa from above downward, and the detached ovum is forced into and through the dilated and thinned cervical canal. The decidua vera is usually the last to be expelled, and it is this that most frequently remains long after everything else has been discharged, owing to the inability of the undeveloped uterine musculature to entirely throw it off. The decidua reflexa may be torn, leaving the other membranes intact, the chorion, amnion, embryo, and amniotic fluid being expelled first, followed by the rest. Rarely, the chorion ruptures with the decidua, leaving the amnion intact, either entirely free from other membranes or perhaps covered at one point by chorion and decidua.

Occasionally, owing to the rigidity of the external os, especially in primiparæ, the ovum becomes fixed in the cervical canal, and it may remain there a long time unless relieved by incision. The term "cervical pregnancy" has wrongly been applied to this condition. The appearance of the extruded mass (Figs. 147, 148) differs according to the causes, the time, and the duration of the abortion, but, as a rule, in the early months the ovum will be found imbedded in a large blood-clot, the coagulum arranged in layers corresponding with successive hemorrhages. When blood-clots are formed at different times between the membranes, there results what is designated a "blood mole." If the coloring matter has been absorbed from these clots, the mass is called a "flesh mole."

FIG. 147.—Specimens from New York Hospital Cabinet, showing the conditions in which ova are found.

The fetus is usually much smaller than it would be at the same time under normal conditions, especially where the cause has been slow-acting. Sometimes the fetus can be recognized only by aid of the microscope, or it may have entirely disappeared after maceration in the liquor amnii. After partial maceration in the liquor amnii the retained fetus may dry up, and finally be expelled in a mummified condition, or, putrefactive changes setting in, it may be expelled piecemeal.

Clinical History.—In a simple, uncomplicated case of abortion occurring before the third month of gestation the patient, with very little if any warning, has a more or less profuse, generally continuous, hemorrhage from the uterus. After a variable period, more or less severe, regularly recurring modified labor-pains occur, due to uterine contractions. Under the influence of the uterine contractions the cervical canal is expanded, the external os is dilated, and the ovum is either forced out entire, imbedded in a large clot,

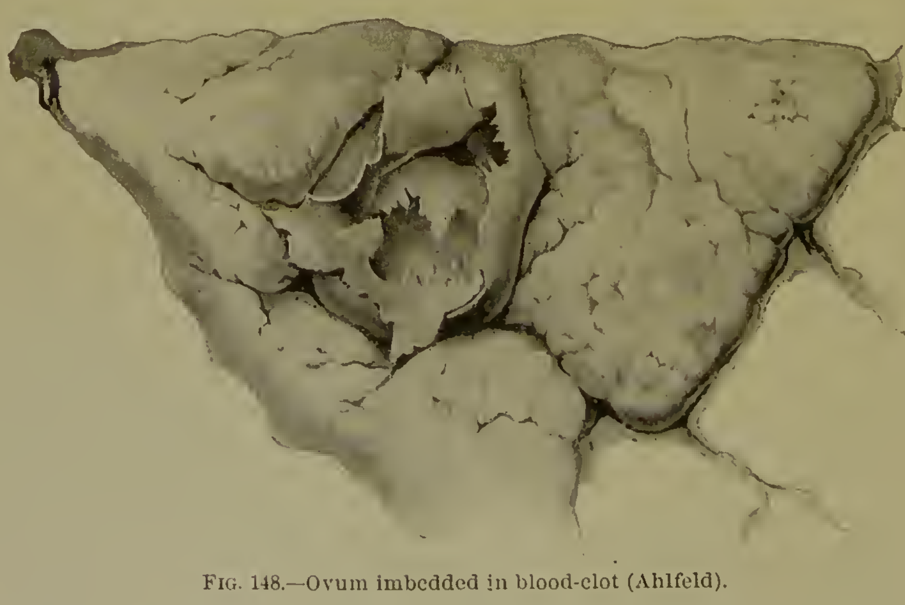


FIG. 148.—Ovum imbedded in blood-clot (Ahlfeld).

or the embryo is first expelled, followed shortly by the already loosened membranes. During the third and fourth months, owing to the more rigid condition of the cervix and external os, the pains become more severe, more force being required of the uterus to overcome the resistance of these parts. Owing to the firmer connection of the ovular to the uterine surfaces, more force is also necessary for detaching the membranes, and, as the uterine muscle is still undeveloped, a greater length of time is taken to complete the abortion. The amniotic sac in these cases usually ruptures before the complete separation of the membranes; the fetus is expelled, generally with a portion of the membranes; and the remaining portions are finally entirely detached and forced out of the uterus. After the fifth month the process more and more resembles labor at term.

The above outline of the clinical progress of simple, uncomplicated abortions occurring before and after placental formation probably does not represent the class of cases usually coming under the physician's care. It will be well on this account to consider briefly the more common symptoms and variations in detail.

Prodromal Symptoms.—Reliable symptoms and signs indicative of approaching abortion very rarely exist before the third month, and they are not constant after that time. The occurrence of shifting pains in the back and abdomen, frequent urination, sometimes nausea and vomiting, and a mucous or watery discharge from the uterus should be a warning of the possibility of approaching abortion, and early and appropriate treatment should be instituted.

Duration of Abortion.—The duration of the abortive process varies according to the period of gestation, the cause of the abortion, and the condition of the os and cervix and the energy of the uterus. As a rule, abortion is slower than normal labor at term. Especially after a fall the ovum, in the earlier period of its development, may be thrown off and expelled instantaneously, or it may rapidly be expelled after a few gushes of blood and a single painful contraction. These cases, however, are but rarely observed.

Hemorrhage and Pain.—In early abortion hemorrhage is the leading symptom, and it is the first that attracts attention in the majority of cases. It is often excessive and alarming, and may be so profuse as to endanger the mother's life. Hemorrhage may precede pain many hours or even days and weeks, or in rare cases it may take place conjointly with pain. It may be very slight at first, cease after a variable period, and then recur, or it may begin with a sudden profuse discharge. Hemorrhage may take place continuously from the uterine surface, but it may only appear at intervals externally in the shape of clots, sometimes collecting in the uterus in considerable quantities before being expelled. This "concealed hemorrhage" rarely happens before the fourth or the fifth month of gestation. The amount of blood lost varies considerably with the period at which the hemorrhage occurs, being, as a rule, less the nearer the abortion is to the end of pregnancy, and it depends to a considerable degree upon the extent of separation of the ovum from the uterine wall, as well as upon the activity of the uterine contractions. Generally the hemorrhage will continue until the uterus is empty. Hemorrhage is sometimes preceded in these cases by the passage of small quantities of dark-colored blood-serum.

The pains of abortion, which resemble those of labor at term in many instances, vary considerably according to existing conditions. Many patients complain that abortion-pains are harder to bear than those of normal labor, and not so easily forgotten. In exceptional cases the pains may begin some time prior to the occurrence of hemorrhage.

Expulsion of Uterine Contents.—Instead of the membranes and the placenta being expelled with the fetus or shortly afterward, a portion or all of the placenta may remain behind, either only partially or wholly detached from the uterine wall, constituting what is designated "incomplete abortion." There may be considerable delay before the remnants are entirely expelled, the process of unaided expulsion requiring days, weeks, and even months, for completion. So long as any portion of the ovum or its coverings remains in the uterus, just so long will the patient be subjected to the risk of hemorrhage and sepsis. Frequently after several days there is a return of hemorrhage and pain, with slow dilatation of the external os, and the decomposing uterine contents come away piecemeal.

Sometimes in twin pregnancies symptoms of threatened abortion will subside without rupture of the membranes, and the pregnancy will continue to term, at which period a living child will be born, and at the same time a dead fetus or "blighted ovum" will be expelled.

Diagnosis.—While there is, as a rule, but little doubt as to the existence of abortion in the majority of cases coming under the physician's care, it is nevertheless true that there are cases where it is quite impossible to make a positive diagnosis, and others in which the diagnosis can only be arrived at after a searching examination into the history of the case, a careful analysis of the symptoms, and a thorough physical exploration.

Where the entire ovum is expelled suddenly, as sometimes happens in early pregnancy after falls or blows, and the expelled mass is either lost or thrown away without being examined, a positive diagnosis is not possible.

In dealing with a case of uterine hemorrhage and pain, unless there be sufficient evidence of its cause, the first point to determine is as to the *existence of pregnancy*. In the early months of gestation this determination may be impossible, and in the absence of positive signs we can only presume that pregnancy does or does not exist. It may be denied by those who may have an object in denying it, or it may be admitted by those who simply believe themselves to be pregnant. Abortion may be simulated in the non-pregnant woman by dysmenorrhea, by pain and hemorrhage caused by the presence of submucous uterine tumors, and may even be feigned by hysterical girls at the menstrual period or by women with intention of blackmail. In the absence of a history of previous attacks of dysmenorrhea, and of a record "running over" two or three months, a vaginal examination should be insisted upon, which examination, with that of the napkins, would probably settle the diagnosis one way or the other. A careful inquiry into the patient's history, together with physical exploration and examination of the discharges, will assist in clearing up doubts in the case of hemorrhage and pain from uterine tumors. The examination of membranes, clots, and pieces of tissue offered in evidence as to abortion will expose any attempt at malingering.

Having determined that pregnancy exists in a case of suspected abortion, the next thing to be determined is whether we have to do with abortion or with something simulating it. Abdominal pain and uterine hemorrhage occurring at the same time in a woman supposed to be pregnant is presumptive evidence, at least, of impending abortion, but such evidence alone is not sufficient for a positive diagnosis. For instance, hemorrhage may take place from a diseased cervix in pregnant women, and at the same time there may be present intestinal colic, neuralgia, stretching of old visceral adhesions, or the discomfort of an over-distended bladder. Nor is the presence of membrane always positive evidence. In extra-uterine pregnancy the expulsion from the uterus of a deciduous membrane, together with more or less hemorrhage, may lead to a wrong diagnosis of abortion. In the latter case the absence of chorionic villi will count against the case being one of abortion.

Pregnancy existing, and abortion determined upon as the cause of the symptoms, the next inquiry will be as to whether abortion is simply *threatening*, whether it is *inevitable*, or whether it has been *completed*. In *threatening abortion* the os uteri is undilated, the cervical canal is unexpanded, the hemorrhage is not profuse, and the pains are easily controlled. In *inevitable abortion* the os is usually dilated sufficiently to admit the index finger, the cervical canal is expanded or expanding, the angle between the upper and lower uterine segments is effaced, the uterine contents are forced down within reach of the finger with each pain, and the hemorrhage and pains cannot be controlled; or profuse hemorrhage alone, if uncontrollable, may be sufficient evidence of inevitable abortion. A critical examination of the discharges from the uterus by floating them in water will often determine whether or not the integrity of the ovum has been destroyed, and will thus assist the diagnosis. Abortion is *complete* when the uterus is free from ovular tissue. The continuance of pains or of hemorrhage, or both, is conclusive evidence that the abortion is incomplete.

Prognosis and Sequelæ.—For the child the prognosis is necessarily fatal. As a rule, the prognosis for the mother is remarkably good, better even than after labor at term, a fatal termination rarely taking place except in badly-managed or neglected cases. The danger of general septic diseases is much less after early abortion than later. Even under conditions that would, if existing at the end of pregnancy, prove most disastrous, such as septic intoxication from putrefaction of retained membranes, rapid disappearance of the symptoms is the rule in abortion under appropriate treatment. But while the immediate danger to the mother's life is less than it is at the termination of pregnancy, the pernicious consequences of neglected or badly-managed abortions are far more common, and not nearly so amenable to treatment.

The nature and severity of the sequelæ vary with the causes. Anemia, with great debility, consequent upon excessive hemorrhage at the time of abortion or upon recurring hemorrhages, the result of subinvolution or of retained fetal membranes, is very frequently observed. Among the more common local results of abortion are acute and chronic inflammatory diseases of the uterus, the ovaries, and the tubes, and of adjacent structures, from a more or less marked septic infection. Such diseases are endometritis, acute cellulitis, pelvic peritonitis, pelvic abscess, salpingitis, pyosalpinx, oöphoritis, etc. Hydatidiform moles, the result of retained chorion, and placental or decidual polypi, the result of retained fragments of placenta or decidua, are often noticed. Secondary infections are not infrequently encountered as a result of abortion. Suppurative arthritis may be mentioned as an example. One abortion nearly always predisposes to recurrences, giving rise to what is known as "habitual abortion," unless the original cause be removed and the abortion be managed in a proper manner.

A most important sequel to abortion is its baneful effect, at times, upon the nervous system. There is scarcely a single manifestation of the so-called "functional nerve disorders," from slight irritability of temper or mental depression to actual insanity, that may not have its origin in a pathological condition the result of abortion. While local irritation alone may be responsible for some of these disorders, the possibility of autoinfection from the slow but continuous absorption of mildly septic material from a chronically inflamed mucous surface should be borne in mind.

Treatment.—In the treatment of abortion we have to consider—1. Prophylaxis; 2. Treatment of threatening abortion; 3. Management of actual abortion and treatment of its accidents; 4. Treatment of incomplete abortion; 5. After-management. Abortion is truly a surgical condition, and its treatment requires and should receive the application of the same well-known principles in regard to the prevention of sepsis as do other surgical affections. Surgical cleanliness is as much indicated in abortion as it is in labor at term.

Prophylaxis.—The prophylaxis of abortion consists in the treatment of all those general and local conditions which predispose the patient to its occurrence, in the restoration of the patient as nearly as possible to normal health before and after conception, and in the avoidance after pregnancy has begun of those exciting causes which are more or less prone to precipitate an abortion, at least in predisposed cases. Local causes, such as tumors in and about the uterus, subinvolution, endometritis and other inflammations, displacements, etc., should be sought for and should appropriately be treated before conception. General pathological conditions, such as tuberculosis, syphilis, anemia, the neuroses, as well as diseases of the thoracic and abdominal viscera, should also receive treatment both before and after pregnancy has begun. As syphilis is probably responsible for a much larger number of abortions than any other single cause, its presence in one or both parents should receive prompt and thorough attention. In those instances where no other cause can be found and there is no indication of syphilis existing in either parent, father and mother should be placed under antisyphilitic remedies, as an apparently cured syphilis may still exist sufficiently to affect the ovum. During pregnancy the greatest care should be taken to avoid all possible sources of irritation, such as fatiguing work, too long walks, riding, dancing, lifting, reaching, stair-climbing, jumping, sea-bathing, corsets, tight clothing, contagious diseases, poorly-ventilated or overheated rooms, crowded theatres or crowded churches, emotional excitement, late hours, etc. The diet should be regulated carefully, in order that acute dyspepsia, flatulence, colic, diarrhea, and constipation may be avoided, and the kidneys and the bowels should be regulated properly. Coitus should be prohibited. The patient should, if possible, spend several days in bed at the times corresponding with the menstrual periods. A retroflexed uterus should carefully be righted and be held in position by an appropriate pessary.

In cases of habitual abortion it would be well for the patient to allow an interval of six months or a year to elapse between the last abortion and the next pregnancy while under treatment. In some cases confinement to bed the greater part of the time seems to be the only way in which pregnancy can be carried through to term.

Treatment of Threatening Abortion.—If upon examination the os is found undilated, the cervical canal unexpanded, hemorrhage not profuse, and pains absent or moderate, the case should be considered as preventible and be treated accordingly. If we knew for a certainty that the fetus was dead, there would be no reason for treating the case as preventible, but as there are no reliable signs of fetal death where abortion is only threatening, we must treat it as though the fetus were alive. Our aim is to prevent, if possible, any further separation of the ovum from the uterus, and to allow of the healing of the already injured surfaces. To this end we endeavor to *control hemorrhage and uterine contractions.*

Absolute rest and quiet are essential to the proper treatment of threatening abortion. The patient should be put to bed in the quietest, best-ventilated room in the house. She should maintain a recumbent position for several days or until all danger is past. She should not rise, even to a half-sitting position, for any purpose, the bed-pan being used for defecation and urination. Everything having a tendency to produce nervous disturbance should be avoided, such as talking, visitors, and worry of any kind. Secure free movement of the bowels each day by sufficient doses of castor oil or other mild laxative, aided, if necessary, by enemata of glycerin and water or of sweet oil. The clothing should be cool and light, the diet nutritious and easily assimilated, but non-stimulating.

In the way of *drugs,* opium in one of its forms is mostly to be relied upon as a general sedative. It should be given in full doses, and repeated often enough to preserve systemic quiet. In some cases it may be advantageous to give with the opium such nerve-sedatives as chloral hydrate, the bromids, or phenacetin. These drugs should be given per rectum if the stomach is sensitive. The fluid extract of viburnum prunifolium in drachm doses is said to assist materially in quieting uterine contractions. Ergot in small doses (15 to 20 min. of the fluid extract) may be of benefit in selected cases (where there is little pain, but much hemorrhage) in assisting in the control of hemorrhage by contracting the arterioles, but as a general thing it should not be used, owing to the tendency for even small doses to excite uterine contractions.

The vaginal tampon, as a rule, should never be used in threatening abortion, on account of its action in exciting uterine contractions. In exceptional cases, however, where there is not much pain, but considerable hemorrhage which cannot be controlled by other means, the tampon may be useful in connection with the sedatives already mentioned. A vaginal injection of hot alum-solution (℥ss–Oj) may be used instead of the tampon. Any malposition of the uterus should be remedied by the gentlest manipulations.

Treatment of Actual Abortion.—If the os is dilated and the cervical canal is expanded, or the pains and hemorrhage continue notwithstanding treatment, and there seems to be no prospect of checking the progress of the abortion, the expulsion of the ovum becomes inevitable. The main indication now will be to *control hemorrhage* and to *secure complete evacuation of the uterus.*

If it has not been done before, the vagina and the external genitals should be placed in as nearly an aseptic condition as can be done with hot water, soap, and an antiseptic solution. The physician's hands and the instruments should also be rendered surgically clean before an examination is made. If the ovum is protruding with membranes unruptured, it may easily be dislodged from the cervical canal, but we should refrain from manipulations that might cause rupture before its complete extrusion.

Before the fourth month we may best meet the indications—to control hemorrhage and to expedite delivery—by the use of a *vaginal tampon.* Properly applied, the tampon will surely control hemorrhage; further, it hastens the complete separation of the ovum by causing an accumulation of blood between the uterus and the membranes, and it is a powerful exciter of uterine contractions. The tampon may be made of a long strip of aseptic or antiseptic gauze, of pledgets of aseptic or antiseptic absorbent cotton or wool, or, in the absence of these materials, of any soft fabric, such as a silk handkerchief, a soft towel, or strips or pieces of sheeting, cheese-cloth, an ordinary roller bandage, etc. Whatever material is used, it is understood it must be sterilized thoroughly by boiling, by dry heat, or by steam, or it may be scalded thoroughly in some hot antiseptic solution. If a large number of pieces are used, as of antiseptic wool, they should be so secured to each other by a string as to facilitate their withdrawal. If the material has previously been prepared or if it can be sterilized by dry heat before using, it is better to use it without soaking in an antiseptic solu-

FIG. 149.—Sims's position for tamponing and curetting (Skene).

tion, as more accurate tamponage can be done when the tampon is dry than when it is wet.

For introducing the tampon the patient should be placed across the bed, or, better, on a table, in the dorsal or in Sims's position, with the hips at the edge of the bed or the table (Fig. 149). A very copious hot-water or hot antiseptic vaginal douche should next be given, after the

FIG. 150.—Frozen section of the uterus, showing placenta and partially-detached membranes (Freund).

bladder has been emptied. The tamponing may be done with the aid of a Sims speculum if assistance is at hand; if not, then a bivalve speculum may be used, or, as is preferred by some, one or two fingers of one hand are introduced into the vagina and there act as a guide. With dressing forceps one end of the strip of gauze or a pledget of the tampon material is passed into the vagina along the introduced fingers, and is accurately packed by them into, against, and about the os and the cervix. The tamponing should be continued in this way until the vagina has been moderately filled. An antiseptic pad is placed over the vulva and is held in place by a T bandage. Moderate doses of fluid extract of ergot (♏xv to ʒss) should be

FIG. 151.—Frozen section of the uterus, showing retained membranes (Freund).

administered every two or three hours, together with quinin or strychnia where these are indicated for debility. If there is much pain, 5 grains of phenacetin will give the patient comfort without interfering with uterine contractions. A second tampon and other accessories should be in readiness before the removal of the first. The tampon should be removed carefully after from six to twelve hours, when, as is usual, the entire ovum or the fetus alone will be found in the vagina or adhering to the tampon. If the ovum has not been expelled or only a portion has been thrown off, we should tampon again, after emptying the bladder and douching the vagina, in the same manner as before.

If after the removal of the second tampon it is found that the membranes have ruptured, and only a portion, if any, of the ovum has been expelled, the uterine cavity should be explored by the introduction of one or two thoroughly antisepticized fingers, the vagina having first received a thorough cleansing with hot water or with antiseptic fluid. If much pain is to be feared or the patient is nervous and resisting, an anesthetic should be employed. If the os is not sufficiently dilated to admit the finger, graduated metal or hard-rubber dilators should be employed. The introduction of the finger may be aided materially by properly applied counter-pressure on the fundus through the abdominal walls. The cavity of the uterus must be explored thoroughly and the retained portions (Figs. 150, 151) be separated, if adherent, and removed. In case the use of the finger is unsuccessful, the adherent mass should be removed by the careful use of a not too sharp intra-uterine curette. The instrument devised by Carl Braun or one similar to it answers the purpose admirably, being at the same time a curette and an irrigator. Either plain hot water or a hot mildly antiseptic solution of creolin (1 to 2 per cent.) or of boric acid (4 per cent.) or straw-colored tincture of iodin, are recommended for irrigating the uterus, as being the fluids least liable to do harm. In the use of the curette great care should be observed lest more harm be done than the good we seek to accomplish. The dangers to be avoided are perforation of the uterus by careless manipulation, and in needlessly injuring, by indiscriminate curettage, uninvolved mucous membrane. After complete emptying and irrigation of the uterus in this way an antiseptic pad should be placed against the vulva.

The tampon is contra-indicated in abortion after the fourth or the fifth month, as the uterus at this period is sufficiently large to contain considerable blood. For the control of hemorrhage rupturing of the membranes is to be preferred, but if tamponage is resorted to the uterus must closely be watched. The ineffectual uterine contractions usually found may be stimulated by from 5- to 10-grain doses of quinin. If after rupture of the membranes, hemorrhage continues, the uterus must be emptied as quickly as possible, the cervix being dilated if necessary, the fetus be extracted, preferably by turning, and the placenta be removed if detached or easily detachable. If the placenta is firmly adherent, it may safely be left for a few days to become detached by natural means, provided the uterus and the vagina can properly be irrigated antiseptically, the former twice in twenty-four hours, the latter from four to six times or continuously. The insertion into the uterus of an iodoform-gauze tampon has been used successfully in these cases. After the placenta has become detached, it and the remaining adherent fragments may be removed in the manner already described, either by means of the fingers or the curette.

Treatment of Incomplete Abortion.—If there is, after the apparent completion of abortion, more or less hemorrhage, either continuous or interrupted, with slightly dilated os and flabby cervix, especially if there be pain and an odor of decomposition, it is evident that some portion of the ovum still remains in the uterus.

In the mildest cases, in which there is as yet no infection of the retained portion and the os is contracted, conservative measures might be advisable in those cases that could be kept under observation and in those in which the treatment could properly be carried out. Such conservative treatment would consist in keeping the patient quietly in bed, stimulating uterine contractions by repeated moderate doses of ergot and by the use of the vaginal tampon, and by keeping the vagina and the vulva in a strictly aseptic condition.

In neglected cases, where there is much hemorrhage or pain, and especially if there be even a minimum amount of fetid odor to the lochia as it comes from the uterus, the indications are clearly to empty the uterus completely and at once—with the fingers if possible, with the curette if necessary; to render the uterus and the vagina as nearly aseptic as possible by antiseptic irrigation, and to keep them so. In the treatment of incomplete abortion, whether the case is seen early or late, there should be observed the same rigid adherence to the principles of aseptic or antiseptic surgery as is observed in any other case.

After-management of Abortion.—There is no valid reason why the woman who has aborted should not require as much time for the repair of uterine lesions and for the proper involution of her enlarged uterus as does the woman who has been delivered at term. Owing to the imperfect development of the enlarged uterus after abortion, the process of involution is even slower than the same process after labor at term. There would be a marked decrease in the number of pelvic disorders, and there would be almost as great a falling off in the number of abortions, if women were treated after aborting more nearly as they are after a normal labor.

Missed Abortion and Missed Labor.—As a child at full term may die and may remain *in utero* for weeks or for months afterward, this condition is called "missed labor." A similar condition—missed abortion—is observed in the earlier months of pregnancy when the fetus dies, the ovum remaining *in utero* for weeks or for months. The symptoms of pregnancy are then arrested; the liquor amnii is absorbed, the abdomen becomes smaller, and milk appears in the breasts. The child *in utero*, surrounded by the placenta and the membranes, becomes macerated or mummified. It does not necessarily become putrid, because the unbroken membranes prevent the entrance of atmospheric germs. In these cases labor does not come on at all, or, having commenced, the pains cease and the fetus is retained.

Oldham was the first to apply the term "missed labor" to cases in which occurred ineffective uterine efforts to expel the fetus and other contents except the liquor amnii. Air does or does not enter the uterine cavity according as to whether the membranes are or are not ruptured. If atmospheric air has access to the fetus, the latter undergoes putrefactive changes, giving rise to a condition known as *physometra* or *tympanites uteri;* the soft parts liquefy somewhat, then escape, leaving the osseous structure. A complete evacuation of all the fetal structures is rarely effected by nature alone. Some of the parts being retained, the projecting bones may penetrate the surrounding uterine walls, and find their way into the vagina, the rectum, the bladder, or through the abdominal walls. A similar action may lead to suppuration, peritonitis, septicemia, and death. Most cases, however, eventually recover, but convalescence is long and very tedious. If air is excluded from the uterus and the fetus is retained, the latter may become mummified, and this mummified product may remain indefinitely without creating special harm. Possibly it may cause irritation, suppuration, and uterine or pelvic abscess and their results. Besides maceration and mummification a prolonged fetal retention may lead to adipocerous changes. Calcification very rarely occurs.

A dead fetus within the uterine cavity, although no air has entered, generally seriously impairs the health and endangers the life of the woman. Consequently, in cases of this kind it is always prudent, after the lapse of a few weeks, and when there is no physical evidence of a commencing expulsion, to induce labor artificially—an obstetrical procedure which under careful precaution is safe, infinitely more so than allowing the dead fetal mass to remain. When nature is successful in partially eliminating some of the fetal portions, active efforts by the hand or by instruments, after cervical dilatation, should be employed to aid the woman. Every known antiseptic precaution should be exercised to prevent or to control hectic symptoms, peritonitis, and septicemia. Laparotomy, laparo-hysterectomy, or a Porro operation may be the very thing to do under certain circumstances.

Müller of Nancy has shown that many cases of so-called "missed labor" are really cases of extra-uterine pregnancy, with ineffectual attempts at fetal expulsion, because of a certain position of the fetal body. With fair propriety it may be said that most of these cases are those of advanced extra-uterine fetation of the intramural (interstitial) or tubal variety, or of retention of the fetus in a bilobed uterus.

7. Extra-uterine Pregnancy.

History.—Extra-uterine pregnancy from the standpoint of its etiology, pathology, and operative treatment has provoked such numerous discussions and has called forth so many valuable essays within the past fifteen or twenty years that the historical side of the subject has received but little attention. From this one-sided view the impression has arisen in the minds of many practical men that this anomalous form of gestation was almost if not quite unknown even to our immediate predecessors. A research into the medical literature of the past four centuries, however, brings to light many clear descriptions of well-recognized cases of extra-uterine pregnancy.

Israel Spach in his extensive gynecological work, published in 1597, figures a lithopedion drawn *in situ* upon a full-length cut of a woman with the belly laid open. He dedicated to this calcified fetus, which he regarded as a reversion, the following curious epigram, in allusion to the classical myth that after the flood the world was repopulated by the two survivors, Deucalion and Pyrrha, walking over the earth casting behind them stones which on striking the ground became people. Roughly translated from the Latin, this epigram reads as follows: "Deucalion cast stones behind him and thus fashioned our tender race from the hard marble. How comes it that now-a-days by a reversal of things the tender body of a little babe has limbs nearer akin to stone?"

We find many of the earliest writers mentioning this form of fetation as a curiosity, but offering no explanation as to its cause. One of the first and most natural suggestions was that the fetus had died *in utero*, and afterward had become displaced into the abdominal cavity, where it excited suppuration and thus was finally discharged.

An important discussion was called forth in 1669 by the case of Benedict Vassal, a surgeon in Corrari, Italy. The great obstetrician Mauriceau's drawing (Fig. 152) of the specimen obtained shortly after the autopsy is remarkably clear, and it well supports his judgment that this was not a tubal pregnancy as asserted. His description of the case is well worth quoting even at this day; translated freely, it is as follows:

"History of a woman in whose abdomen there was found, after death, a small fetus about 2½ inches long, together with a great quantity of coagulated blood.

"The history of this case deserves to be carefully considered to decide whether the fetus, as believed by many, was generated in the ejaculatory vessel, called the tube of the womb. On the sixth of January, 1669, in the village Corrari, I saw in the hands of a surgeon named Benedict Vassal a uterus which he had removed a short time before from the body of a woman aged thirty-two, who had died after three days of the most agonizing pains in the stomach, from which she had fallen into frequent fainting spells and the most violent convulsions. This woman had borne eleven children at term, but in her twelfth pregnancy, at about two and a half months, the womb dilated in the direction of the right horn, and, unable to withstand this distention, ruptured. The fetus was expelled into the abdomen, and was found with a great quantity of coagulated blood among the intestines of the mother. Many physicians, surgeons, and naturalists betook themselves to this surgeon to see the uterus which was exhibited by him as a prodigy, as he insisted that the fetus was formed in the ejaculatory vessel, which Fallopius calls 'the trumpet of the womb.' They accepted at once, without further investigation, that this was just as the said surgeon claimed, and that this case confirmed stories of a like nature narrated by Riolanus. However, I examined the parts of the uterus most carefully and minutely, and it was evident to me that those who accepted this opinion had been led into error; for this reason, that at the time I made a drawing of the womb as it then appeared, and this is a more faithful and accurate reproduction than that which this surgeon had engraved upon copper after a month had elapsed, as the uterus then retained almost nothing of its primitive form, and was spoiled by the handling of a thousand men or more who had seen the uterus, pulled it, disturbed it, and turned it inside out that they might examine it.

"Many have adduced this case to prove to us that the testes" [ovaries] "of women are full of little ova which at the moment of coitus free themselves and emerge from the body proper of the testes, and are thence borne into the uterus through the tube, to serve for the generation of the fetus. They claim that one of these so-called ova had by chance remained in the tube of this woman, instead of passing forward into the uterus, and that this was the cause of her death.

"Regner de Graaf among others holds this opinion, for the confirmation of which he brings forward the figure of this uterus, which the surgeon of whom I have spoken had already given to the public; as one finds it on the 260th page of his book on the 'Generative Organs of Women.' Any one

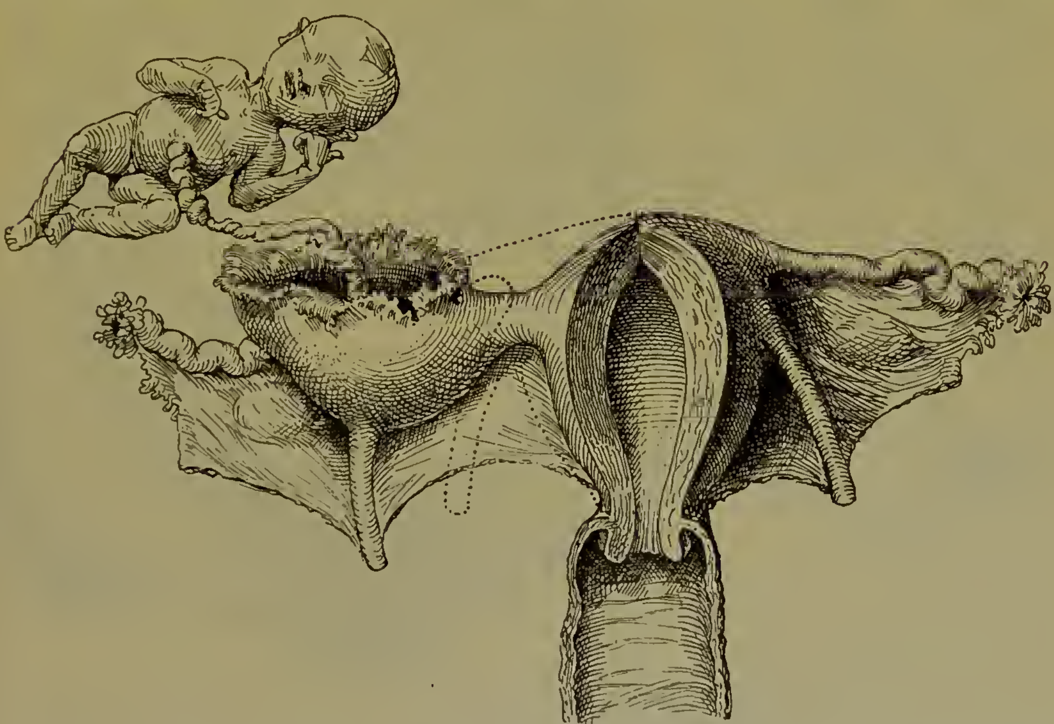


FIG. 152.—Case of extra-uterine pregnancy figured by Mauriceau, redrawn, but practically unchanged. The fetus is here shown attached to the sac, which was not the case in his figure. The distinct neck between the sac and the uterus is evident; the round ligament comes out of the under surface of the sac more toward its outer pole. The relations of a normal uterus are indicated by Mauriceau in dotted lines.

who will examine, carefully and without prejudice, the following figure, which is most faithful and faultless, and at the same time look into our reasons, will find that we have given another demonstration which we believe to be the true explanation."

Mauriceau with great insight then cites the anatomical relation of the round ligaments to the body of the uterus as substantiating his view of the case. He says, "Behold how clearly I demonstrate that this part in which the child was contained was a portion of the body proper of the womb, and not the tuba uterina, and this because the round ligament is constantly attached directly to the lateral wall of the body of the womb, called the cornu, and at this place it becomes fused with the substance of the womb. It is therefore certain that the part where the ligament ended (Fig. 152), and at which it was strongly attached on the right side, where the malformation existed, was a portion of the womb itself; consequently the child was engendered in a part of the womb that was elongated."

It is interesting in this connection to note that Mauriceau, in this differential diagnosis, anticipated some of the results of our latest investigations concerning the differences between tubal and cornual interstitial pregnancy and

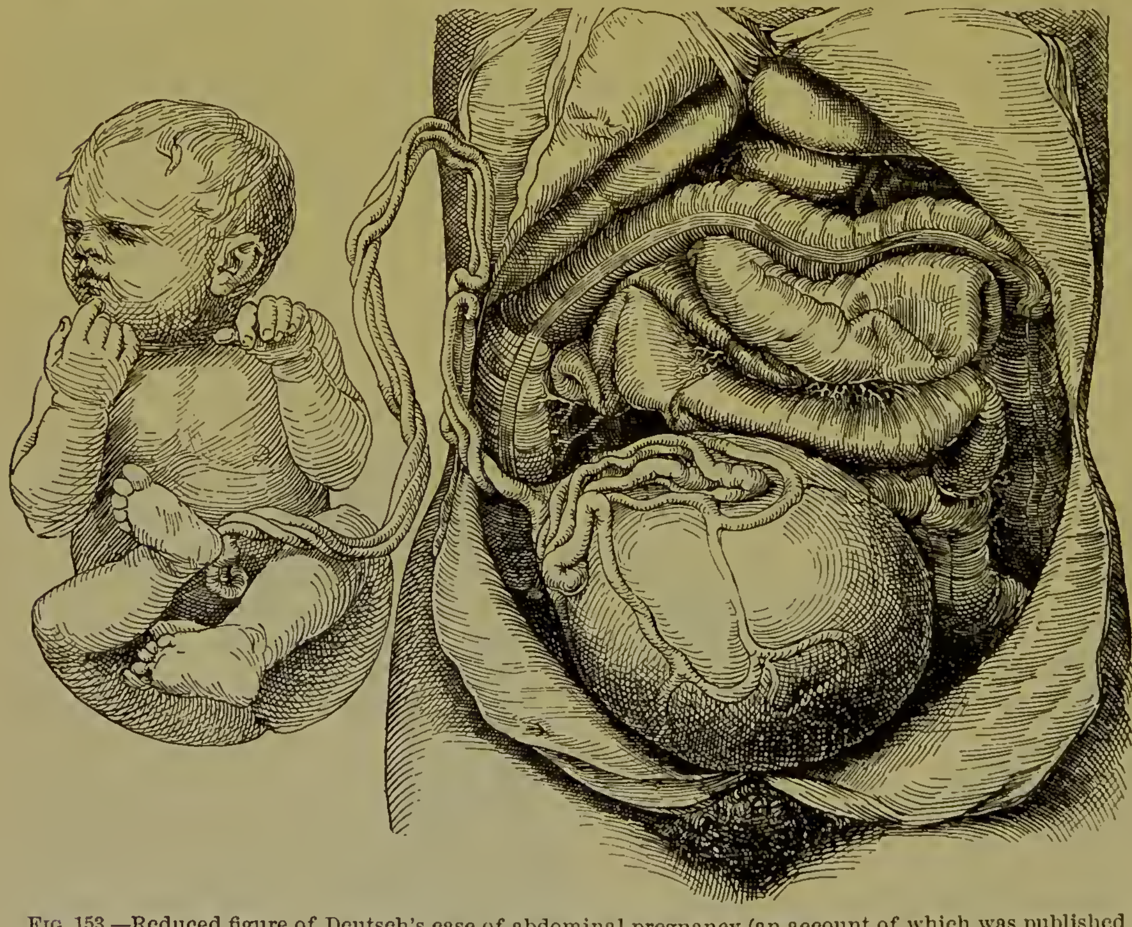


FIG. 153.—Reduced figure of Deutsch's case of abdominal pregnancy (an account of which was published in 1799 with life-size copper-plate engravings).

pregnancy in a rudimentary horn. From the above it is evident that Mauriceau was positive that impregnation had not occurred in the Fallopian tube, but in one cornu of the uterus, and that the ovum had developed as a hernia from the uterus. I find that Regner de Graaf, just as Mauriceau states, accepted the view of Vassal, and in his description of the Fallopian tube reports the case and reproduces the figure from the copper plate which Mauriceau condemns. De Graaf believed this to be a case substantiating his own theory regarding the function of the ovaries and the Fallopian tube. He says, "We judge that the tubes called Fallopian in women and in every kind of female are true vasa deferentia, or, if you prefer, oviducts, inasmuch as the ova are transmitted through them to the uterus." He further says, "The tube or horn [Fallopian tube] of the womb is dilated and affected by semen corrupted there and seeking an outlet; but it is remarkable that the male semen should reach that point and that a fetus should have been conceived there, as is proved by histories."

De Graaf believed that the ova were fertilized in the ovaries and that they were then carried downward into the uterus, where they remained until the full term of gestation was completed. He does not offer any explanation for the arrest and development of the ovum in the tube; on the contrary, he distinctly states that he does not know why it occurs. He recognized, however, the dangers of this anomalous pregnancy, as indicated by the following statement: "The ovum already fertilized is detained in its transit in the tubes, and by its increase in size brings death to the mother." In his critical remarks upon Vassal's case he says: "And from this our opinion it is not difficult to explain how a fetus occasionally develops in the abdominal cavity among the intestines, inasmuch as the ova already impregnated fall from the testes" [ovaries] "outside the cavity of the tubes and are nourished by the neighboring parts."

From these references to the earlier literature it will be seen that ectopic gestation was clearly recognized, its symptoms graphically described, and the theories advanced those that are accepted by many writers of the present day.

Numerous other contributions are found in the literature of this subject, following De Graaf and Mauriceau, one of the most interesting being figured in the obstetrical work of Peter Dionis of Paris, published in the early part of the eighteenth century.

Even so early as 1741, Bianchi constructed an elaborate classification of the forms of extra-uterine pregnancy, that was simplified by Boehmer in 1752, who described three forms—"gestatio ovarica," "gestatio tubaria," and "gestatio abdominalis." From the time of Boehmer a period of forty-nine years intervened in which this classification remained practically unchanged. In 1801, Schmidt described the interstitial form of ectopic gestation, and with this addition Boehmer's classification must practically be accepted even at the present day, with the exception of a primary abdominal form.

Etiology.—No entirely satisfactory conclusions have yet been reached regarding the cause of this anomalous form of pregnancy. Among many theories none have been demonstrated. One great difficulty lies in the fact that it has not yet been determined at what point in the female genital tract normal impregnation of the ovum takes place, and until this question is settled the primary question, whether extra-uterine fetation is an abnormal ectopic impregnation or is simply a detained impregnated ovum, must remain unanswered. Many claim that the seat of coalescence of the male and the female elements is normally in the Fallopian tube. If this claim be admitted, it can readily be seen how a variety of causes might operate to detain the ovum in the tube, where it may continue to develop extra-uterine. Chief among the causes ascribed a few years ago, at the revival of this subject, was the loss of the tubal ciliated epithelium, which would manifestly conspire to prevent the ovum from being carried on down into the uterus; other causes cited have been flexions of the tube, dilatations and diverticula, constrictions from inflammatory changes, and polypi in the tube, closing its lumen like a valve.

While a variety of causes may operate, it is most probable, from the frequency with which old inflammatory disease is found coexisting on the other side, that most cases of tubal gestation arise from ileus of the tube, resulting in an inability to transmit the contents of the tube, due to adhesions. An important cause, operating in cases where the pregnancy is toward the outer end of the tube, is the presence of a diverticulum, as pointed out by J. W. Williams.

Classification: Primary Forms.—The primary forms of extra-uterine pregnancy are classified as follows:

1. Tubal:	Tubo-uterine or interstitial. Isthmial. Ampullar.	2. Ovarian.

Secondary forms are derived from the primary, as follows:

(*a*) From the interstitial:	Uterine; Broad ligament; Abdominal.	(*c*) From the ampullar:	Tubo-ovarian; Abdominal; Broad ligament.
(*b*) From the isthmial:	Abdominal; Broad ligament.	(*d*) From the ovarian:	Abdominal; Tubo-ovarian.

In tubal pregnancy, when the fertilized ovum develops out near the fimbriated extremity of the tube it is called *ampullar;* at the inner portion of the tube it is called *isthmial;* while in that part of the tube which traverses the uterine wall it is designated *interstitial* or *tubo-uterine.* It is in the latter form that the term *extra-uterine* pregnancy becomes a misnomer, as the conception is not, strictly speaking, extra-uterine, being enclosed in the wall of the uterus, although outside its cavity. For this reason Mr. Tait suggested the term *ectopic* gestation. Many writers, more practical than scientific, were misled by Mr. Tait's dicta to go so far as to hold that there is but one form of ectopic gestation—namely, the tubal—and so able a pathologist as Bland Sutton gives them countenance by his denial of the ovarian and abdominal forms, as he considers the cases which have been reported do not sufficiently demonstrate their existence. No criticism, however, has yet succeeded in destroying the claims of cases of Leopold, Patenko, and Martin, which we must accept as primarily ovarian. In Leopold's case the patient was operated upon for a pelvic tumor of twenty-five years' standing that proved to be an ovarian tumor containing a lithopedion. In the walls of the tumor ovarian stroma was clearly demonstrated. Patenko's case is even more striking. The right ovary was the size of a hen's egg, and it contained a cyst with smooth walls in which was found a yellow body, the size of a hazel-nut, composed of cylindrical and flat bones. These bones, which were submitted to a careful microscopical examination, were found to be fetal in origin and not the product of a dermoid cyst. The enveloping wall contained corpora lutea and follicles. The tube of the affected side had no adventitious connection with the ovary, and its fimbriated extremity was entirely free, although the internal ostium was closed and some of the fimbriæ were gone. Opponents of the theory of ovarian pregnancy take exception to this case, claiming that the gestation was primarily tubal, and that a so-called "tubal abortion" had occurred into the ovary, and that later the ovary and the tube had become detached from each other!

Martin of Berlin reports two cases which he believes to be examples of undoubted primary ovarian pregnancy. In these cases the gestation-sac was

FIG. 154.—Prof. August Martin's case of ovarian pregnancy. The intact tube is seen lying above the ovarian sac containing the fetal envelopes.

situated entirely within the ovary, the fimbriated extremity of the tube being intact. As an explanation of ovarian pregnancy Martin advances the very natural suggestion that the spermatozoön finds its way through the fimbriated extremity of the tube into one of the small recently-ruptured cysts so frequently found on the surface of the ovary, and that it there coalesces with the ovum.

Too few observations have yet been made to prove the possibility of primary abdominal pregnancy, although the case of Schleetendahl is difficult to explain upon any other hypothesis. In this case a fetus measuring 15 centimeters (6 inches) in length was found attached to the abdominal wall near the spleen in a woman who had died of hemorrhage. The gestation-sac was surrounded by adherent intestines, and the uterus and appendages appeared normal. For the present, however, only two primary forms of ectopic gestation —tubal and ovarian—can positively be accepted. Practically, tubal pregnancy is the only primary form found.

Secondary Forms.—The secondary forms of ectopic pregnancy are derived from the primary. The tubo-uterine or interstitial pregnancy may rupture into the uterus and be followed immediately by expulsion of the fetus, or it may go on to full term and be delivered in the natural way. This mode of termination, unfortunately, is rarer than two other possibilities—namely, rupture into the abdominal cavity or rupture into the broad ligament. In the isthmial form of tubal pregnancy the rupture occurs either into the abdominal cavity, thus forming a secondary abdominal pregnancy, or into the broad ligament, forming extra-peritoneal, broad-ligament pregnancy. The ampullar form of tubal pregnancy gives rise to secondary tubo-ovarian, abdominal, or broad-ligament pregnancy.

Tubal Pregnancy.—In the first week after fecundation of the ovum the tube begins to thicken, due chiefly to vascularization without hypertrophy of the muscular fibres. In this respect the tubal envelope differs in its development from that of the uterine muscle in normal pregnancy. In the latter case there is hypertrophy of the individual muscle-fibres to eleven times their length in a normal non-pregnant uterus; the connective tissue, peritoneal covering, blood-vessels, and lymphatics being also increased by hypertrophy and hyperplasia, so that at full term the uterus weighs two pounds instead of two ounces, the weight of a virginal uterus. The thickening in the pregnant Fallopian tube is due to excessive vascularization with but slight increase in the tissue-elements. As the pregnancy progresses the wall of the tube becomes thinned and stretched until in some cases it appears as a thin transparent membrane composed only of an attenuated stratum of muscle covered with peritoneum.

The development of the fetal membranes derived from the ovum, with the exception of the placenta, is the same as in intra-uterine pregnancy. Normally, the placenta is derived about equally from the decidua serotina of the uterus and the chorion frondosum of the ovum. In tubal pregnancy Bland Sutton holds that the placenta is largely fetal in its origin. As the embryo increases in size and the walls of the tube become stretched, the plicæ in the mucous membrane lose their characteristic appearance and are gradually smoothed out. During the first four to six weeks the abdominal ostium of the tube becomes hermetically sealed. Until the fetal membranes are well formed the life of the fetus is in constant jeopardy, as the chorionic villi have but a feeble hold upon their points of attachment to the tube and may easily be dislodged. This termination is most favorable from the first to the third week of the pregnancy, and it may be so harmless as to give rise to no serious discomfort.

An apoplectic ovum thus detached appears as a lump of coagulum, and unless carefully examined its true character may be overlooked. Such bodies, known as "tubal moles," are absolute proof of the nature of the pathological condition. As the pregnancy advances the formation of the tubal mole is attended with much greater danger, as the accompanying hemorrhage often causes rupture of the tube, followed by rapid death of the mother. These moles, if recent in origin, will be found to contain the embryo and its membranes. The absolute diagnostic point is the discovery of chorionic villi or of the embryo itself. If extruded into the abdominal cavity or into the broad ligament the mole loses its characteristic appearance and soon becomes enveloped in a yellowish coat of fibrin, and there may be such complete disintegration of the fetal tissues as entirely to obliterate its embryonic characteristics. The villi, however, are most persistent, and they may be found after the other evidences of their origin have disappeared. These villi have the same appearance under the microscope as those of normal pregnancy.

If the ovum continues to grow, the point at which the placenta is attached is of the greatest importance to the mother, as upon this largely depends her chance for life in case of rupture. If the placenta is implanted on the superior wall of the tube, the mother is in constant peril, as rupture here may be followed by frightful hemorrhage, the lacerated or detached placenta having no counter-pressure to control its bleeding, as is the case when it is attached to the floor of the tube. For this reason many surgeons claim that this termination is invariably fatal. If the placenta is implanted on the floor of the tube, the chances of rupture are not necessarily decreased, but the dangers attending this accident are far less to the mother. In this position the placenta is pushed downward against the resisting pelvic floor, insinuating itself between the layers of the broad ligament. If the embryo is extruded through the upper wall of the tube, the placenta may still retain a firm attachment and only slight hemorrhage follow, and the immediate danger be escaped in this way. Occasionally the ovum is lightly attached in the ampullar extremity of the tube, and is extruded into the abdominal cavity without rupture of the tubal walls. This extrusion is known as "tubal abortion." As evidence of this the fimbriated extremity of the tube is found enlarged and patulous, and there is free blood in the abdominal cavity, in which the tubal mole may be found if the abortion is recent.

Tubo-uterine or Interstitial Gestation.—The history of the embryonic development in this type of ectopic gestation differs from the tubal proper on account of its difference in environment. Here the muscular fibres of the uterus undergo the same changes as in normal pregnancy. Rupture is almost inevitable, but it does not occur so early as in the tubal variety, on account of the greater thickness of the walls surrounding the gestation-sac. Hecker collected twenty-six cases in which rupture occurred before the sixth month. The fetus occasionally escapes into the uterus, and it is either expelled at once or it goes on to regular term and is born in the natural way. Rupture occurs most frequently into the abdominal cavity, and in such cases the hemorrhage is profuse and usually terminates the patient's life in a short time. Interstitial pregnancy is rarely recognized before rupture.

Rupture of the Sac.—The time of rupture of the sac depends upon its location and, to a certain extent, upon the attachment of the placenta. In tubal pregnancy primary rupture occurs usually between the second and the fourteenth week. When the placenta is implanted on the floor of the tube, the probability is that the rupture will not take place so early as when it is situated on the superior wall. The causes of rupture are thinning of the walls of the tubes beyond the limits of elasticity, hemorrhage into the sac, traumatism, and gradual enlargement of the embryo. If the patient survive the primary rupture, the fetus may still continue to develop, either burrowing downward between the layers of the broad ligament or growing upward into the peritoneal cavity among the intestines. The injury to the placenta is much less when it is situated on the pelvic floor, as the displacement is not so marked, the hemorrhage is not so profuse, and consequently the lives of the fetus and the mother are in less jeopardy at the time of rupture. If blood is poured into the peritoneal cavity, it will usually be absorbed; if the collection of blood occurs between the layers of the broad ligament, it constitutes pelvic hematocele (Fig. 155). When the fetus becomes intra-ligamentary and continues its development in that position, it is known as *broad-ligament gestation.* After the twelfth week the sac is liable

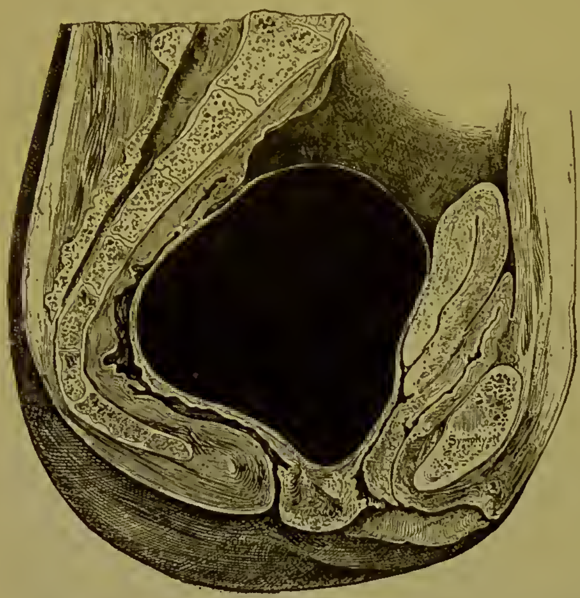


FIG. 155.—Diagram showing pelvic hematocele posterior to the uterus, which is crowded forward with the bladder behind the symphysis pubis, while the rectum is compressed behind against the sacrum (Skene).

FIG. 156.—Ruptured left tubal pregnancy, fetus still attached and lying within the pelvis. Hydrosalpinx and adhesions on the right side. Uterus displaced toward the right by the sac: *u* is the fundus uteri; *r*, the rectum; *t*, the right closed tube; *f*, the fetus; and *s*, the ruptured extra-uterine sac.

to secondary rupture at any time up to term. Here again the situation of the placenta is of the same importance in the prognosis as in the primary rupture.

The Fetus.—The question as to the possibility of life for the fetus is influenced by the location of the pregnancy. In the tubal variety the most favorable attachment of the placenta is on the floor of the Fallopian tube, as there may be slight if any disturbance of the fetal circulation if the rupture be in the superior wall of the tube, when the child may go on to full term (Figs. 156, 157). Even, however, if the ectopic fetus be delivered alive, it is often deformed and puny and rarely lives more than a few days. For this reason its life should be but little regarded in the treatment of ectopic gestation.

The disposal which nature makes of the fetus in case the mother survives the rupture is also of considerable interest. The dead embryo lying free in the abdominal cavity may be completely absorbed up to the second month; after that period it either undergoes mummification, calcification, or is converted into adipocere, or decomposes. Mummification is analogous to the change which bodies undergo in a dry atmosphere. A mummified fetus in its general appearance closely resembles bodies found in arid regions buried in

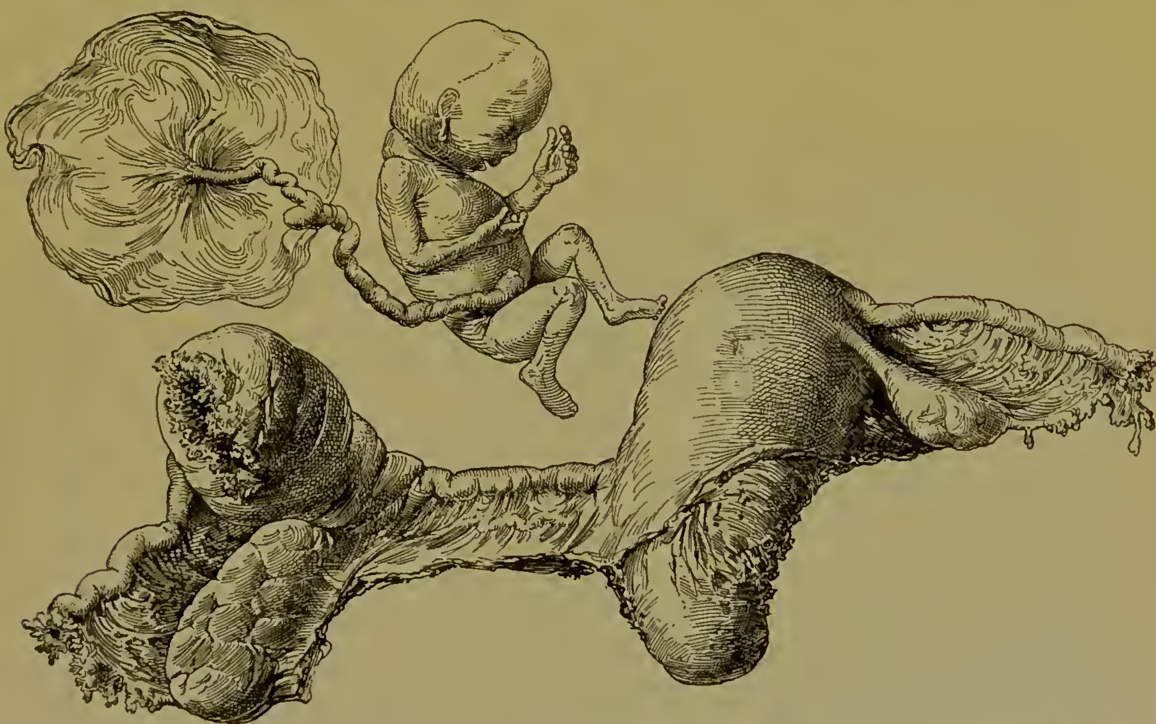


FIG. 157.—Cornual pregnancy. In this case rupture occurred in the right undeveloped cornu of a bicornute uterus (from a specimen presented to the writer by Dr. Watson of Baltimore).

dry soil or in sand or exposed to the air. The fluid constituents of the extra-uterine gestation are absorbed, and the soft tissues become leathery or parchment like. In other cases the fatty elements are converted into adipocere or into ammoniacal soap in the presence of ammonia formed by the decomposition of the tissues. Either the mummified or the adipocere fetus may still undergo further change and become partially or wholly calcified. This process is not entirely confined to the superficial parts, as there have been described a number of specimens which exhibited the saponaceous or the mummification process on the exterior while the internal organs were calcified. A fetus which has undergone calcification is known as a *lithopedion*.

The fetal mass may remain indefinitely in the abdominal cavity without giving rise to any discomfort to the mother. Cases are reported in which such bodies have stayed for ten and fifteen years, in one instance for fifty-four years, in the pelvis without giving rise to serious trouble. On account of the close anatomical relation between the gestation-sac and the rectum and intestines a slight rupture of the intervening walls may occur at any time, or a diapedesis may take place and pyogenic organisms gain access into the sac and induce suppuration. The fetus is then converted into a putrid mass, which may be discharged into the rectum, the vagina, or the bladder. Occasionally the suppurating mass ruptures at some point on the anterior abdominal wall even so high as the umbilicus. The latter termination is frequently noted in the older medical literature.

Symptoms.—All the symptoms characteristic of normal pregnancy may be present. Frequently, however, the subjective symptoms are entirely absent, and the patient may be quite unconscious of her condition. The increase in the areolar circle around the nipple and other mammary changes, the gastric disturbance, pain on the affected side, associated with amenorrhea, are the most characteristic symptoms. Too much stress, however, must not be laid upon the absence of the menstrual flow, as it is subject to the greatest variations. In some cases instead of amenorrhea there will be profuse metrostaxis with the expulsion of small bits of decidua.

It is of importance not to confuse the decidua of ectopic pregnancy with that of membranous dysmenorrhea. In the latter condition the decidua is usually expelled in small pieces and rarely as a cast of the interior of the uterus. When floated out in water numerous delicate velamentous processes are seen. This membrane is rarely more than one or two lines in thickness, and it is usually very friable. The decidua of ectopic pregnancy is much thicker, varying from 5 to 20 millimeters ($\frac{3}{16}$ to $\frac{3}{4}$ inch); it is much less friable, the uterine surface being covered with a thick, shaggy, villous coat, and instead of small bits it is usually expelled in large pieces or as a complete cast of the interior of the uterus. Pain is variable, in some cases being almost constant, in other cases absent. The character of the pain before rupture may be sharp and lancinating, or there may be dull and heavy aching. The statement of the patient that she considers herself pregnant is of some value, as that ill-defined sense upon which she bases her opinion may be the only subjective indication of her condition. The appearance of the external genitalia may be the same as in normal pregnancy. Under these circumstances the vaginal mucous membrane appears purplish in hue, the cervix is soft, the os uteri is usually closed with a plug of mucus, and the uterus, instead of its pyriform shape, is now globular and enlarged to the size of a one-month pregnancy.

If an examination be made before rupture, the Fallopian tube of one side will be found enlarged, and if far advanced the uterus will be forced from its position in the median line by the growth of the tumor. If the pregnancy is advanced to the third or the fourth month, a circumscribed tumor, well defined as an area of dulness on the anterior abdominal wall, may be outlined by percussion. Vaginal examination reveals this tumor lateral and posterior to the uterus, with a well-marked sulcus between it and the uterus. Unfortunately, it is only in the rarer instances that a physician is called before rupture occurs, when, unless he is a skilful specialist, the probabilities are that ectopic gestation will not be suspected. The growth of the tumor may give rise to pressure-symptoms, such as constipation and dysuria, but they are of little special significance, as any pelvic tumor may be attended with similar disturbances.

Rupture.—The symptoms of rupture are very characteristic, and they usually are so definite as to cause little doubt in diagnosis. A patient previously healthy or only slightly complaining is suddenly seized with severe abdominal pains, sharp or lancinating, cutting or agonizing. The attack in many instances cannot be ascribed to external violence or to undue exertion on the part of the patient, as she may be in the midst of light household work, or walking on the street, or even be in bed when the rupture occurs. Previous to the attack she may have had no discomfort or only the slight disturbances of pregnancy. If the hemorrhage is extensive she may fall unconscious as if struck a blow. The pulse, at first rapid, soon becomes almost or quite imperceptible; the respiration is quickened, then becomes jerky, and finally the air-hunger so characteristic of severe hemorrhage becomes pronounced; vertigo, nausea, and vomiting are present. The symptoms soon merge into those of profound shock, the extremities being cold and clammy, the skin pale, the conjunctivæ pearly, and the lines about the mouth drawn. If the patient is conscious and is able to talk, she will usually complain of intense abdominal pain. Death may follow soon after intraperitoneal rupture, or it may be delayed for a day or even longer. In some instances the bleeding ceases for a short time and is followed by gradual improvement in symptoms, but it again begins a few hours or some days later, and the patient survives only a few minutes.

In extraperitoneal hemorrhage from rupture into the broad ligament the symptoms may not be so urgent. The initial attack in both instances is similar, as the peculiar sharp pain at the onset is due to rupture of the tube. The blood as it accumulates usually checks the hemorrhage by its own pressure, and the patient may have no further trouble. If the embryo dies at the time of primary rupture into the broad ligament, no further discomfort is felt, as a rule, as a harmless hematocele is all that remains. Unfortunately, in many instances this is not the termination, and the fetus continues to develop, and sooner or later a secondary rupture occurs, attended by the same symptoms as the primary rupture.

In the rarer cases, which go on for nine months, labor-like pains come on and closely simulate those of normal parturition. These pains may continue for hours or even for days, and then cease. The escape of blood and of portions of the decidua occurs in a majority of cases at this time, and may mislead the attending physician into the diagnosis of abortion if the constitutional symptoms are not urgent. The subjective symptoms of pregnancy are almost always present in such advanced cases. The fetal movements may have been so much on one side as to call the mother's attention to this phenomenon. The fetal heart-sounds are distinct, being heard with unusual clearness.

In cases surviving the rupture the sharp labor-like pains gradually subside, the secretion in the breasts disappears, the tumor decreases rapidly in size, and as soon as the patient recovers from the shock and loss of blood she may regain her health. It is in these cases that absorption or one of the other changes that render the fetal body innocuous takes place. Infection of the incarcerated fetal mass may occur at any time, even years after the death of the embryo, followed by a train of symptoms similar to those attending pus-formation from other causes.

Diagnosis.—The history, if carefully reviewed, often directs attention strongly toward ectopic gestation. The pregnancy usually occurs in a multipara some years after the birth of the last child, although it may follow shortly. There may have been an intervening attack of acute inflammation of the tube or of pelvic peritonitis. This is strongly insisted upon by those who advocate the theory that tubal gestation is due to an old inflammatory process which has changed the normal histology of the tube.

A characteristic history is as follows: A woman who has borne one or more children, after an interval of from five to twenty years of sterility observes symptoms of another pregnancy. Her menses, which have been regular, cease, and the morning nausea, pain in the breasts, darkening of the areola, and other symptoms characteristic of her former pregnancies appear. In addition to these symptoms, she has in one ovarian region dull pain, at times so severe as to cause her to seek the advice of her physician. This pain may continue until it culminates in the acute paroxysms caused by rupture, or it may cease, and not be noticed again until the rupture occurs. The most characteristic symptom of all is the sudden sharp pain of the rupture. If followed by a marked anemia it is still more decisive. The bimanual examination, taken in conjunction with this history, points with absolute certainty to the nature of the pregnancy, and the diagnosis is comparatively simple. In the atypical cases, on the contrary, a positive diagnosis is often difficult or even impossible.

In the normal uterine pregnancy, as the embryo develops the uterus is distended equally in all directions, but occasionally the ovum develops in one corner, distending the uterus on that side, which may prove misleading. In pregnancy occurring in the rudimentary horn of a bicornute uterus the symptoms are so nearly alike that a differential diagnosis is not likely to be made.

Kussmaul collected thirteen cases of pregnancy in rudimentary cornua, the majority of which had been reported as tubal pregnancies. If an exploratory section be performed in these doubtful cases, the anatomical points insisted upon by Mauriceau are of the greatest value in making a differential diagnosis. They are as follows: In cornual pregnancy the round ligament is situated anterior to the outer side of the gestation-sac. In tubal pregnancy the round ligament is situated on the uterine side (Figs. 157, 158).

Pregnancy occurring in one horn of a well-developed bicornute uterus may go to term and give rise to no untoward symptoms. A pregnant uterus deviated to one side by a myoma may be mistaken for ectopic gestation. The diagnosis, however, can usually be made if the examination is conducted under anesthesia, as it will be found that the tumor varies its position with that of the enlarged uterus, and is directly continuous with it, in addition to being densely hard. The question of interstitial pregnancy naturally arises in these cases, and if the character of the tumor cannot be recognized at the first examination, the patient's symptoms should be observed carefully, and she should be examined again later to decide whether there is any increase in the size of the suspected tumor. If there is a perceptible increase, the probabilities are that it is interstitial pregnancy. An adherent retroverted gravid uterus may also give rise to misleading symptoms, such as sharp pains, obstinate constipation,

FIG. 158.—Diagrammatic sketch showing relations of an unruptured sac (*s*) to uterus (*u*), round ligament (*rl*), and bladder (*b*). The numerous adhesions are suggestive as to the etiology.

pelvic pressure, dysuria, etc., but it is readily differentiated by a bimanual rectal examination, if necessary drawing the uterus down with traction forceps so that the fundus may readily be palpated.

Ovarian tumors and enlargements of the Fallopian tubes, associated with intra-uterine pregnancy, may cause confusion, especially if the tumor lateral to the uterus gives rise to sharp pain, as may occur in pyosalpinx. In such instances the question of a twin pregnancy, one intra-uterine and the other extra-uterine, must be considered. As fever accompanies pyosalpinx in the majority of cases, it must carefully be considered in the differential diagnosis. If it be impossible to arrive at definite conclusions concerning the suspected mass, and the life of the patient seems in peril, an exploratory celiotomy is justifiable, otherwise expectancy is the safer course. Occasionally a pedunculated ovarian cyst becomes strangulated by axial rotation: such an accident is accompanied by pain, vomiting, rapid pulse, and other constitutional disturbance, at times amounting to profound shock. Rupture of an ovarian cyst may also be difficult to differentiate from the rupture of an ectopic gestation-sac; in such cases the history and the vaginal examination will clear up the diagnosis.

To summarize briefly, it may be said that the diagnosis of ectopic gestation depends upon the following cardinal points:

1. A history of probable pregnancy.
2. Paroxysmal pains, usually located on one or the other side of the pelvis.
3. Irregular metrostaxis.
4. The expulsion of bits of decidua.
5. Coincident enlargement of the uterus and softening of the cervix and discoloration of the vagina.
6. Tumor lateral or posterior to uterus and indirectly connected with it, uterus moderately or not at all enlarged.
7. Changes in the breast.
8. Anemia.

The diagnosis of ectopic gestation after the death of the fetus is largely dependent upon the clinical history; if this be deficient, the diagnosis is frequently impossible, especially if there has been a long interval between the rupture and the time when the patient consults the physician. If the fetus has undergone calcification, it may be felt as a hard mass, but even this is not conclusive, as a calcified myoma may present similar characteristics.

Treatment.—From the operative standpoint it is best to divide ectopic pregnancy into the following periods:

1. Before rupture; 2, at the time of rupture; 3, after rupture; and 4, after calcification, saponification, mummification, or suppuration of the fetus has occurred.

1. *Before Rupture.*—The electrical treatment, so much advocated a few years since for the destruction of the fetus, while valuable in its day as pioneer work, has deservedly fallen into disrepute, because of its uncertainty in terminating the fetal life and of its dangers to the mother through subsequent inflammation. The injections of fluids into the sac for the same purpose is so utterly foreign to present ideas of treatment that it is only mentioned to be condemned. The proper course to pursue is the removal of the affected tube. Precipitate operation, however, is not advisable, as the diagnosis should be as accurate as possible before resorting to radical measures. Cases with a history suggestive of ectopic gestation and a mass lateral to the uterus detected by vaginal examination should be operated upon without hesitation. A proportion of such cases will prove to be pyosalpinx or hydrosalpinx, but an error is not serious, as in either instance operation is indicated.

2. *At the Time of Rupture.*—If called at the time of rupture, the surgeon must exercise considerable judgment in his decision whether or not to operate immediately. If the patient is in collapse, the pulse weak and rapid, and the skin blanched and clammy, an immediate examination should be made to discover if possible whether rupture has occurred into the broad ligament or is intraperitoneal. If the rupture has taken place into the broad ligament, a lateral tumor-mass closely connected with the uterus will be

detected. The mass is circumscribed and fluctuating, and rectal examination shows the cul-de-sac to be free of fluid. In such a case the method of treatment is an expectant one, the possibilities being that the hemorrhage will soon cease if it has not already done so, and that the patient will recover, leaving

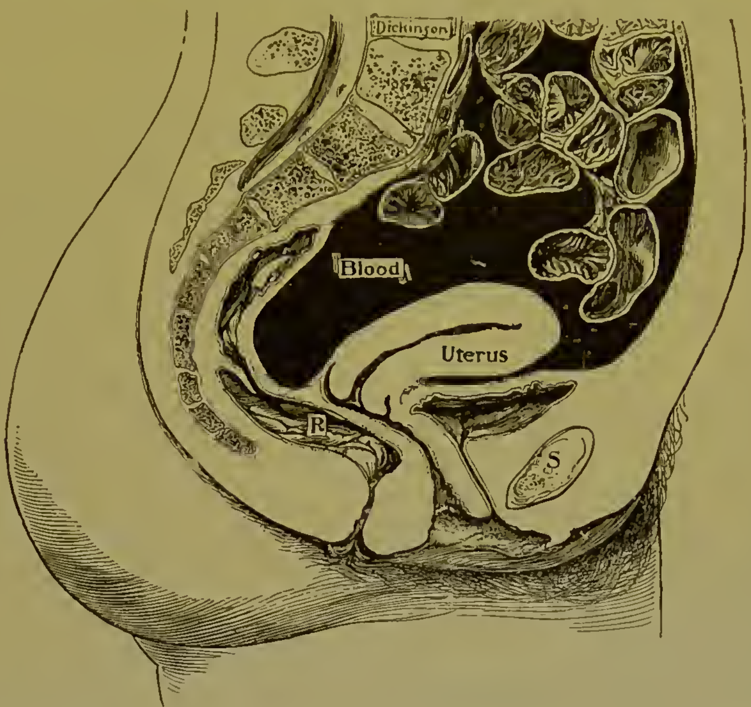


FIG. 159.—Diagram of intraperitoneal rupture of tubal pregnancy. Free blood in Douglas's cul-de-sac and among the intestines (Dickinson): S, symphysis; R, rectum.

a hematocele to be dealt with later if necessary. If examination reveals free fluid in the cul-de-sac (Fig. 159), and there are no signs of improvement in the patient's condition, the natural inference is that the rupture is intraperitoneal, and an immediate operation is indicated, as every moment detracts from the chances of recovery (Fig. 160).

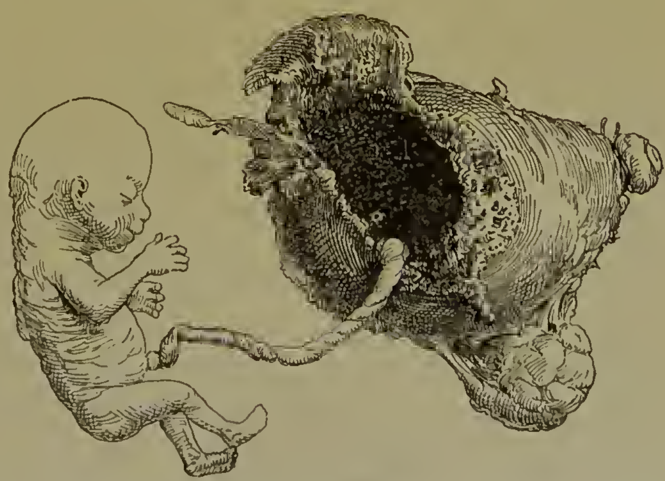


FIG. 160.—Dr. Peck's case (Youngstown, Ohio) of extra-uterine pregnancy in the third month; operation at time of rupture; recovery.

Preparation for Operation.—The chances for recovery following operation in extra-uterine pregnancy depend upon the careful observation of all the details of antiseptic and aseptic technique. For this reason a precipitate operation is always attended with greater danger, as of necessity care in details must be sacrificed. The surgeon should always have a complete set of abdominal instruments and accessories sterilized and packed ready for use. If the operation is hurried, select a welllighted room or provide a portable electric light; remove all unnecessary furniture, dampen the floor to prevent dust rising, but do not disturb the curtains and other hangings further than is absolutely necessary. A common kitchen table can be turned into an operating-table, with a chair inclined against one end, upon which the patient's feet may rest. Cover the table with a folded blanket, lay upon this a Kelly ovariotomy pad, and place a small pillow at the head.

As it may be necessary to irrigate, a douche-bag should be suspended in a convenient position near to, and about 4 feet above the level of, the table. Two smaller tables are required for the instruments and dressings, and three or four chairs for the wash-basins and sponge-dishes. A room thus hastily improvised serves admirably for an operating-room.

An abundance of boiled water is necessary. Directions should be given immediately after deciding to operate concerning the preparation of the water. A wash-boiler or other large tin vessel must be scalded thoroughly, and be partially filled with water which is allowed to boil for an hour if possible. It is best to let the water cool to 110° F., but if time is pressing pure cold water from a well or a hydrant may be used for reducing it to proper temperature. This method of cooling the water, however, is not advisable except under stringent necessity.

Great care must be observed by the physician in disinfecting his hands: they should be scrubbed thoroughly with a nail-brush with soap and water, followed in succession by immersion in permanganate of potassium (hot sat. sol.) and oxalic acid (hot sat. sol.). A quart of each of these solutions is sufficient. The patient, under anesthesia, is then transferred to the operating-table and is rapidly prepared for abdominal section. The anterior and lateral surfaces of the abdomen are thoroughly washed with soap and water, followed by alcohol, then by ether, and finally by bichlorid solution (1 : 1000). As it may be necessary to open the sac through the vagina, this passage should be washed thoroughly with soap and water, followed by bichlorid solution (1 : 1000) and an iodoform pack. All dressings, towels, and gauze to be used in immediate proximity to the field of operation must be provided by the surgeon, who should always carry them among his accessories, as the sterilization of these articles cannot be entrusted to an untrained person. Instruments are taken from their sterilized envelope and placed on towels or in trays.

During the preparation the patient should be given a stimulating enema, also strychnia (gr. $\frac{1}{40}$) and brandy hypodermatically. In such cases as these the infusion of normal salt-solution into the radial artery is often of the greatest service in sustaining the patient's vital forces, and occasionally it is absolutely necessary to save life. It is unnecessary to carry a special infusion apparatus, as an ordinary aspirator admirably serves the purpose. To prepare normal salt-solution dissolve 6 grams of sodium chlorid in one liter (a quart) of boiling water and boil for some minutes. Select one of the smaller blunt-pointed aspirator needles. Fill the aspirating bottle three-fourths full of the solution, cork tightly, and, instead of making a vacuum in the bottle, force in air until the pump works with difficulty, then turn the entrance stopcock. The radial artery is the most accessible for infusion, as it can be utilized if necessary for this purpose by an assistant while the abdominal operation is in progress. Cut down somewhat obliquely on the artery, and place a provisional ligature above and below the point of infusion. When ready to introduce the fluid invert the bottle, turn the exit stopcock, and insert the needle into the artery while the fluid is flowing, thus preventing the possibility of introducing air. The dangers of this accident, however, are practically of no moment if the fluid is injected centrally into the artery.

If the exsanguination is extreme, a liter (a quart) of solution at a temperature of 105° F. may be infused. After the needle is withdrawn both ligatures are tied and the wound is closed with a subcutaneous stitch. It is remarkable how quickly the pulse improves under this infusion: it may grow weaker shortly after, but if the bleeding is completely checked the chances for recovery are far greater if infusion is employed. The fluid used must be perfectly free from dirt or bits of cotton, etc., which produce emboli and cause gangrene.

The Operation.—The abdomen should be opened freely in the median line; the clots should be turned out, exposing the ovarian and uterine arteries, which are caught either with forceps or between the fingers. If on attempting to clear the pelvis of clots fresh blood wells up, no further time should be lost in attempts to expose the bleeding points, but the operator must introduce his hand into the pelvis, grasp the arteries, and then apply hemostatic forceps. Having controlled the active hemorrhage, he can then carefully cleanse the abdomen of clots, inspecting closely the débris as he does so for the embryo or the tubal mole. If the pregnancy is in the first or second month, the operation consists of a simple salpingo-oöphorectomy; if, however, the term is farther advanced and the placenta is extensively attached to the interior of the tube, or in case of previous rupture to the intestines and pelvic walls, the operation is not so simple, and calls for good judgment to know how best to deal with the placenta. It is exceedingly hazardous to attempt the removal of a placenta which is firmly attached, as the hemorrhage following its dislodgement may be so extensive as to defy control. In such cases it is best to leave the placenta *in situ*, for to attempt its removal would take away any chance the patient has for life in her condition of shock and exsanguination.

No means further than those necessary to save life at the time of operation should be undertaken, as the essential principle is first to control hemorrhage, leaving subsidiary conditions for subsequent consideration. If the placenta be attached exclusively to the floor of the tube or the pelvis, its blood-supply may be derived from numerous vessels, and an attempt to control these by ligation would be impossible. The best course to pursue in such cases is to check the hemorrhage, tie and cut the cord close to its placental origin, and leave the placenta undisturbed. Drainage should not be employed in these cases, because of the increased danger of sepsis. The proper treatment is to close the abdomen completely, and after the patient has recovered a second operation may be performed for the removal of the placenta if it cause untoward symptoms. The greatest care in aseptic and antiseptic details should be observed, as upon the absence of infection depends the patient's chance for recovery when the placenta is not removed. If the operation is absolutely aseptic, the prognosis is good, as the placenta atrophies and gives no further trouble. If, however, the case is infected, suppuration of the placental mass occurs, terminating in general peritonitis or in a pelvic abscess. Often in the course of an operation the placenta becomes detached and may be removed with the fetus. In all cases in which the operation follows the death of the fetus by some days or weeks the placenta is only held by the slightest attachment or it may lie free in the gestation-sac. It is for this reason that the operation is more favorable at such a time, as the dangers of hemorrhage are much decreased.

In some cases, especially those in which there is a temporary cessation of the bleeding, the slightest disturbance of the sac after the abdominal cavity is opened causes a renewal of the hemorrhage. Bold surgical measures are then demanded: the operator should sweep his hand rapidly around the ectopic sac, loosening the adhesions, after which the sac is delivered from its bed of adhesions. The points of bleeding can then be reached and controlled. Adhesions to the omentum should be tied off in small sections to prevent necrosis *en masse*.

If the intestines crowd down into the field of operation, and if the operator is unable to pack them back satisfactorily with sponges, the patient should be placed in the Trendelenburg position. In case there is extensive oozing on the floor of the pelvis after the removal of the placenta, that it is difficult or impossible to control by ligatures, a strip of iodoform gauze should be packed down upon the bleeding points. If there is a large amount of débris scattered throughout the abdominal cavity, free irrigation with sterilized normal salt-solution (6 per cent.) at a temperature of 110° F. should be employed; 3 or 4 liters (3 or 4 quarts) of the solution may be necessary to cleanse the cavity. There is no danger from the distribution of this material in the abdomen by irrigation, as the ectopic product is sterile except in the rarest cases.

In all ectopic cases that undergo operation the opposite tube and ovary should closely be examined, and if normal or if only slightly adherent they should not be removed; otherwise their extirpation is demanded, for to allow a diseased tube and ovary to remain, which can be of little if any further functional value, would only subject the patient to the dangers of a subsequent ectopic pregnancy or to the discomfort and pain due to adherent appendages.

3. *After Rupture.*—Contrary to the natural inference, cases are not usually submitted to operation at the time of rupture, as by the time the surgeon is called the patient is either recovering or is dead from extensive hemorrhage. In a certain proportion of cases the patient, although feeling the sharp pain accompanying the rupture and being compelled to keep to her bed for a day or so on account of weakness, does not call her physician, as she considers it

only a trifling matter associated with her pregnancy. There is undoubtedly a considerable number of cases like the latter in which the death of the fetus occurs at the time of rupture and no further symptoms are observed, and the patient makes a perfect recovery. It is for this reason that a statistical table compiled for the purpose of ascertaining the rate of mortality in extra-uterine pregnancies due to rupture is fallacious. If the surgeon sees the patient immediately after rupture, and there is a general tendency to improvement in all her symptoms, he should defer operating until a future date, to be determined by the patient's condition.

If the rupture be extraperitoneal in a case in which the pregnancy has advanced only to the first or second month, an operation should not be performed unless the fetus continues to develop in its new location or untoward symptoms arise from the hematocele. To subject a woman to an operation for a hematocele which is giving her no trouble is, to say the least, bad judgment. If the life of the fetus is not destroyed at the time of rupture, the operation should be performed as soon as the patient has recovered from the primary rupture. The life of the fetus must not influence the determination to operate, and under no circumstances should operation be delayed on account of sentiment in its behalf.

As the dangers of operation greatly increase as the pregnancy advances toward term, on account of the development of the placenta increasing the dangers of hemorrhage, the earliest date possible should be selected for operation. A free incision should be made in the central line of the abdomen. If the pregnancy is in the early weeks, the operation may be no more difficult than a salpingo-oöphorectomy for pyosalpinx or for hydrosalpinx. The danger of hemorrhage, however, from the broad ligament is somewhat greater than in the ordinary salpingo-oöphorectomy, on account of the increased vascularity of the tube, and great care should be exercised in placing the ligatures so that they will control all blood-vessels. The transfixion needle should not be employed for this purpose, as the subsequent shrinkage of tissue following the removal of the vascular tube is liable to dislodge the ligature, as more tissue is usually included, and a larger size of silk is employed, than when the ligament is tied off in small sections. The pregnant tube when the ligatures are laid should be lifted well out of its bed with a medium-sized curved needle armed with a carrier. The medium-sized silk suture is the best in this location, as it stands sufficient strain easily to control hemorrhage, and yet does not strangulate the tissues *en masse*. Each suture should overlap, in an imbricated manner, the one placed immediately before it; thus no vessels can possibly escape ligation.

If pregnancy is further advanced and adhesions have formed between the gestation-sac and the adjacent viscera or the pelvic floor, or if it is a broad-ligament gestation with the placenta firmly implanted on the pelvic floor, the operation becomes one of the most difficult in abdominal surgery. The adhesions should be dissected off carefully, all bleeding points should promptly be ligated, and the sac should be enucleated in the ordinary manner. Drainage should not be used if it can possibly be avoided; only persistent oozing which cannot be controlled by ligatures justifies its employment, as the dangers of infection are greatly increased by leaving the abdominal cavity open.

The fact that particles of clots and other débris are scattered throughout the abdominal cavity does not indicate drainage, as such material is innocuous if the field has been kept aseptic, and it will give no trouble if the wound is hermetically sealed. It is in these densely-adherent or broad-ligament cases that enucleation of the sac is often impossible, and that other measures must be resorted to for the relief of the patient. The treatment of the ectopic sac then becomes a question of great importance, as the adhesions to neighboring viscera or to the pelvic floor may be so extensive as to preclude its removal, as the danger of hemorrhage following its enucleation is too great in such cases. This question should usually be decided after the abdomen is opened. The extent of adhesions and the vascularity of the sac and adjacent tissue should be noted carefully, and if of such a degree as to contra-indicate removal, the next measure, that of making an extraperitoneal opening, must be resorted to.

Extraperitoneal Evacuation of Gestation-sac.—The point of opening depends entirely upon the location of the sac: if it is situated low in the pelvis and is of easy access through the vagina, unquestionably the best method of procedure is to evacuate the contents of the sac into that canal and establish free drainage. The best method of opening the sac is as follows: After carefully examining the pelvic mass and deciding where the accessible point for opening is—usually in the fornix—the operator thrusts a pair of medium-sized sharp scissors, guided by the index finger of the vaginal hand, into the sac, and withdraws them partially open; this is followed by larger scissors, which are also withdrawn in the same manner. While doing this it is usually best for the operator to have his assistant press the sac gently downward through the abdominal incision. After evacuating the embryonic débris with the fingers or with placental forceps, the sac should be irrigated freely with sterilized water or with a very weak bichlorid solution (1 : 20,000), followed by warm water. After cleansing the sac thoroughly it can be packed with iodoform gauze, care being taken to leave a free opening for subsequent discharge.

The greatest care must be observed in passing from the abdominal to the vaginal operation, as to make a vaginal examination followed by the manipulation necessary to evacuate the sac by the vagina, and then to close the abdomen without the most careful disinfection of the hands, would be an unpardonable mistake. It is usually best for the operator to entrust the closure of the abdomen to his assistant. If the sac, instead of being in close relation with the vaginal fornix, is found to be pushed up above the uterus, and is situated nearer the anterior abdominal wall, the vaginal method of treatment is not advisable, as there may be an intervening space communicating with the general peritoneal cavity between the ectopic sac and the vaginal fornix, making it both difficult and dangerous to reach the sac. In these cases it may be necessary to stitch the sac to the abdominal wound, and then to make an extraperitoneal opening into it. As a rule, however, the sac will be attached by close adhesions to the abdominal wall above Poupart's ligament, and should be opened in this region. The sac should be washed out freely as in the vaginal method, and be packed with gauze.

The after-treatment in these cases is often of great importance, as the sac fills up very slowly and there is constant purulent discharge. The fistula must not be allowed to close. As a rule, the gauze which is inserted at the time of operation should be withdrawn one piece at a time. After the removal of the last piece, usually about the second or third day, fresh gauze should be inserted, the cavity being first freely irrigated with some mild fluid, such as boracic-acid solution (semi-saturated).

4. *Operation after the Fetus has undergone Mummification, Calcification, Saponification, or Suppuration.*—The fetus may remain for years in any one of these conditions, except that of suppuration, without injury to the mother's health. Soon after the death of an ectopic fetus the liquor amnii is absorbed, the placental circulation ceases, and the vascular connection between the fetus and the mother is broken. The liquid portion of the ectopic product is gradually absorbed, leaving in many instances the fetus isolated in its sac as an innocuous body. In such cases operation should not be performed so long as the patient's health remains good, but on the first indication of constitutional disturbance, especially if febrile in character, celiotomy for the removal of the foreign body should promptly be resorted to. If suppuration occurs and the pus-sac opens into the rectum, the vagina, the bladder, or externally through the abdominal wall, the fistula should be enlarged and the fetal débris be removed. The sac should then be irrigated frequently until it fills with granulation tissue. These sinuses heal with difficulty, and they may be persistent.

8. Diseases of the Fetus in Utero.

Under this head only a *résumé* of the diseases occurring before birth will be noticed. There are many conditions which give to the fetus immunity to disease and to injury during the pre-natal state, such as the protection given by the liquor amnii, the uterine wall and bony pelvis, etc., but there are also many predisposing causes, such as hereditary influences from the mother and from the father, nervous disturbances, high temperatures, bad nutrition, diseases of the womb and its appendages, and certain infectious diseases, which have their influence upon the growth and development of the fetus, and which are not only accountable for disease, but sometimes also for the death and expulsion of the child before it has reached its full term. Certain tendencies to disease are inherited : this pertains more particularly to abnormal conditions of the nervous system and to disorders in nutrition. Drunkenness, epilepsy, diabetes, phthisis, and cancer of either parent are unfavorable to the health and development of the child. Frequently a fetus of such parentage dies *in utero*.

1. Infectious Diseases.—Pregnancy does not give immunity to infec-

tious diseases. If the mother is suffering from one of the infectious diseases, the fetus may escape infection, but generally it suffers, either indirectly through the low state of nutrition or the high degree of temperature of the mother, or directly by a transmission of the disease itself. In either event the pregnancy may be interrupted by premature death and expulsion of the fetus, or, if the fetus is born alive, it usually dies soon after birth.

The mode of infection is often obscure, and the path or paths of its transmission are still unsettled questions. Ziemssen holds that the poison circulates in the blood. The transmission of disease-germs from mother to fetus has in some instances been demonstrated. Placental infection producing sepsis *in utero* will be considered later. Pus-organisms have been found to be transmitted to the fetus in septic disease of the mother, and well-formed collections of pus have been observed in a fetus at the time of birth.

All infections of the mother do not seem to be equally severe in their effects on the child. Pregnancy complicated by *la grippe*, cholera, diphtheria, typhoid and malarial fevers in the mother is very likely to be interrupted. It seems probable that in most of these cases the death of the fetus is produced by direct transmission of the infection from the mother, and in many cases this has been demonstrated by finding the disease-germs in the fetus.

So far as his researches into the subject have gone, the writer is not aware that there are any instances upon record of children being afflicted with diphtheria, mumps, or whooping-cough at birth; but children are born with all the pathological indications of malarial disease, such as enlarged spleen, etc., and Playfair states that the agitation caused by the chill is even felt by the mother as her child *in utero* passes through this particular stage.

Cases of congenital recurrent fever have been reported. The fetus usually dies, and shows all the pathological changes which characterize this disease—enlarged spleen, pigment in the spleen and portal blood. Albrecht reports a case in which he found the spirilla of recurrent fever. According to Bemis of New Orleans, the fetus of a woman who recovers from yellow fever is immune to the disease. As regards typhoid fever, while a pregnant woman is liable to take this infection, and the presence of the disease proves in many cases the cause of abortion, the writer does not know that there is a case on record of a child being born with unmistakable typhoid lesions. In the case of a mother affected with cholera early abortion is the rule, but if the child is born alive it usually survives but a few days. The theory of intra-uterine transmission of the bacillus is supported by the microscopical examinations of Tissom and Cattam.

2. Eruptive Diseases.—Of the eruptive diseases contracted in the prenatal state, variola, scarlatina, measles, and erysipelas have been observed in their typical form. Eruptive diseases seem to affect the child *in utero* to a greater degree than any other diseases; they are very likely to produce abortion, possibly on account of infection of the endometrium.

Scarlatina and Measles.—There are a considerable number of cases on record of children being born in the different stages of scarlatina and measles.

When scarlatina occurs in pregnancy the fetus is usually, but not invariably, infected.

The prognosis as regards both mother and fetus is grave, especially if the maternal infection occurs at or near the time of labor. Leopold Meyer mentions an epidemic in which twenty puerperal cases became infected.

Variola.—In about 50 per cent. of cases of pregnancy complicated by variola abortion takes place. In the hemorrhagic form it is almost certain to do so. Manifestations in the fetus do not always occur at the same time that they do in the mother. A case is on record where the mother in apparently good health gave birth to a child with the small-pox eruption upon it. Vaccination of the mother will sometimes protect the fetus.

Erysipelas is likely to interrupt pregnancy. Cases of intra-uterine transmission of erysipelas have been cited by several reliable authors. Lebedeff found in the fetus of a mother suffering with the disease the erysipelas coccus. Erysipelas affecting the mother in the puerperal state may be transmitted to the new-born child. The *prognosis* is more serious than that of a case outside of the puerperal condition.

Tuberculosis.—A child born of a mother suffering from tuberculosis is usually puny, feeble, and predisposed to pulmonary disease. The question of the possibility of direct transmission of tuberculosis to the fetus has recently been the subject of considerable investigation.* Several cases of transmission of tubercle bacillus from the human mother to the fetus *in utero* have been reported by Keating, Jacobi, and others. The fact that the placenta sometimes contains tubercles would show that in those cases the bacilli were introduced through the maternal circulation. From clinical observation of cases we may also deduce—(1) tuberculosis may be transmitted by either parent, and (2) that the bacilli may gain access to the fetus through the (*a*) maternal blood, (*b*) through the areas of tuberculosis, such as the peritoneum, intestines, etc., and (*c*) from the outer world through the genital tract.

Fetal Syphilis.—Perhaps the most important as well as the most fatal disease which affects the child *in utero* is syphilis. It is one of the chief causes of abortion.

Mode of Transmission.—Syphilis may be transmitted by either parent. If a mother who is healthy becomes infected during pregnancy, the child may escape if this infection takes place in the last month, unless the child again becomes infected at birth or while nursing.

Prognosis.—The earlier in pregnancy infection of the mother takes place, the more likely is the fetus to die. If the infection occurs during the first three months and is not subjected to treatment, the fetal mortality during the first few days after delivery reaches 100 per cent. The prognosis is a trifle better if infection occurs during the fourth or the fifth month (Étienne). As a

* The theory of congenital tuberculosis has found support in the experimental research on lower animals, also in cases of the human fetus, described by Johne (Fig. 1, *Fortschritte d. Medicin*, Bd. iii., No. 7) Merkel (Fig. 2, *Zeitschrift f. klinische Medicin*, 1884, Bd. viii.), Birch-Hirschfeld, and others.

rule, infection of the mother is safer for the fetus than infection of the father. Whether the spermatozoa of the infected father may infect the mother is undecided. All authorities do not admit the possibility of infection of the fetus unless the mother is syphilitic, but modern authorities (Tarnier, Schroeder, Charpentier, Priestley, and others) assert positively their belief in the transmission of syphilis to the ovum without infection of the woman.

Diagnosis of Fetal Syphilis.—The infection of the fetus may be inferred if either parent had acquired syphilis at a day not too far remote from the time of procreation. The limit of safety has not been discovered, but the more recently the father has suffered with this disease the more likely is he to transmit it in severe form. Often the signs of fetal syphilis can be looked for only in the fetus after its expulsion from the uterus. In many cases the child is prematurely born, and there are traces of the disease; in other cases the child is born apparently healthy, the disease developing in the course of from two to six weeks. The evidence of syphilis, whether the baby is born dead or whether the disease makes its appearance soon after birth, is usually characteristic. (Premature death of the fetus, due to syphilis, is considered on page 310.) If born alive, the child is often prematurely born, and presents during the whole of its infancy, and perhaps during childhood, a prematurely old look. There is usually marked general debility. Among the first manifestations of hereditary syphilis is snuffles. The coryza is followed by a characteristic rash consisting of erythema and erythematous patches about the anus, the genitals, the thighs, and the forehead. The upper lip is likely to become excoriated and fissured. The mucous membrane of the larynx may be affected, producing hoarseness, and there even occurs ulceration of the larynx.

Pemphigus is one of the most characteristic of syphilitic lesions. A little later roseola, the maculo-syphilides, psoriasis, vesicles, and pustules may also occur. Sometimes mucous patches appear; these may occur around the anus, the vulva, the groin, and the lips, and sometimes in the folds of the neck. Coryza may result in caries of the nasal bones. Syphilitic infants are liable to suffer from broncho-pneumonia.

Congenital syphilitic pneumonia occurs in two forms—white hepatization (Virchow) and the interstitial form. The white hepatization produces enlargement of the lungs, the cut surface presenting a mottled grayish appearance. The alveoli are filled with fatty epithelial cells. The interstitial form consists of increase of connective tissue between the alveoli; there may also be yellow induration, due to gummata on the pleural surface or scattered through the tissues.

Icterus and cyanosis are frequent symptoms of syphilis. The occurrence of the symptom of icterus is explained by syphilitic hepatitis, which in the new-born is of a different character from syphilis of the liver in the adult. Infant hepatic syphilis is always hereditary (Chauffard): the blood carrying the infection arrives in that organ, and the process is markedly profuse, rendering the organ at an early stage diffuse and massive. In the healthy infant the liver should constitute one-thirtieth part of the body-weight; in a syphilitic child this proportion is much exceeded, in some cases having formed one-eighth of the weight of the body. The liver presents two changes—the gummata and diffuse infiltration of connective tissue. This form of cirrhosis is usually of the hypertrophic form. Cyanosis is dependent either upon premature birth or upon syphilitic changes in the lungs, for gummata and white hepatization in the lungs are found with frequency.

The tendency of syphilitic infants to hemorrhage will again be alluded to under the subject of *Hemorrhagic Diathesis.* This form is designated by Behrend as *syphilis hæmorrhagica.* It usually attacks children of premature birth who are either born dead or live only a few hours. In these children are found all the changes which characterize congenital syphilis: numerous extravasations of blood under the skin and in the internal organs, also at times great quantities of blood in the stomach and intestines, in the peritoneal cavity, and in the membranes of the brain. If such children live for a little while, then frequently new hemorrhages appear in the skin and in other organs. Ruge saw a syphilitic child present hemorrhage about the anus, at the point of the tongue, and, finally, about the eighth day of life, severe umbilical hemorrhage. The hemorrhage occurred directly out of the skin like drops of sweat. Further, upon the ninth day severe icterus developed and the child died. The autopsy showed well-developed syphilitic changes in the internal organs. Edema frequently occurs in this hemorrhagic form.

Tenderness and swelling of the long bones are strong evidence of hereditary syphilis. The most characteristic change in fetal syphilis occurs in the bones. The white line which normally marks the juncture of the epiphysis with the diaphysis becomes broader, often irregular, and yellow from fatty changes following a premature attempt at ossification; in marked cases there is also thickening of the periosteum and perichondrium. The diaphysis is sometimes sclerotic. Some authors (Müller and others) regard these processes as quite different from those of rachitis; others consider them identical. The question of identity between the two must be considered unsettled. The thymus gland is often much enlarged, and may present multiple abscesses.

The treatment of fetal syphilis is mainly prophylactic. In parents who are syphilitic the disease may be eradicated by long-continued treatment. Great benefit may be derived from treatment of the mother during pregnancy. If after thorough treatment for the disease, conception does take place, the result may be a child free from syphilis. Étienne, from a study of thirty-two cases of pregnancy in syphilitic women, concludes that the mortality of the fetus in cases where the mother has never been under treatment is enormous, reaching 95.5 per cent. If treatment be applied throughout pregnancy, we may hope to obtain complete immunity from this infant mortality. If a mother who has been infected recently, or who has had a number of miscarriages due to syphilitic infection, is again pregnant, antisyphilitic treatment should at once be instituted. Mercury and iodid of potassium are the most reliable remedies.

3. Congenital Deformities and Malformations.—Amniotic Bands.—One of the conditions to which many deformities are due is the formation of

amniotic bands. Simonart differentiates three classes of amniotic bands according to their origin and insertion—the feto-amniotic, the fetal, and the amniotic. Very often the anomaly consists only in the existence of these bands, but sometimes their existence is the cause of serious disturbance in the normal development of the fetus, giving rise either to cleavage or to strangulation, which in turn explains many of the malformations.

Adhesions between parts of the fetus and the amnion are favored by a deficiency in the amount of the amniotic fluid. If these points of adhesion become firmer or vascular, they may persist, and if the process develops at an early term of fetal life, the regular development at that point will be arrested, giving rise to morphological anomalies which consist in the failure of union between two parts, such as hare-lip, extroversion of the bladder, etc. If these amniotic bands are attached to the edge of the fetal cleavage, the cavities are particularly likely to remain open, giving rise to ectopia (Müller).

Strangulation.—Amniotic bands disturb the development of the extremities chiefly by producing constrictions, causing at the peripheral end edema or atrophy. If this strangulation takes place at a very early date of fetal life, then the growth of that part will be greatly arrested, so that the peripheral end beyond the constriction is proportionately small; in other cases it produces death of the part and the so-called "spontaneous amputation."

Intra-uterine Amputation.—It is now generally admitted that the existence of amniotic bands is one of the causes for intra-uterine amputation (Fig. 161). This amputation usually takes place early in fetal life. Sometimes there are a number of these bands, and they persist to the time of birth. The other causes recognized as such are inflammatory processes and intra-uterine fractures. Virchow attributes them to primary inflammation followed by cicatrix and disturbed nutrition. Simpson holds that there is a causative relation between intra-uterine fracture and spontaneous amputation, the healing processes being unfavorable for fractures. The bone-ends may perforate the vessels and thus interrupt the nutrition of the extremity, causing a sequestrum.

FIG. 161.—Ectromelus (intra-uterine amputation).

Intra-uterine fractures occur occasionally, and they are usually due to external violence, notwithstanding the protection of the fetus by the amniotic fluid and the maternal body. Abnormal muscular contraction of the fetus and a diseased condition of the bones are other causes. A syphilitic osteochondritis may result in separation of the epiphysis and diaphysis of the long bones, simulating fractures. Next to external violence, advanced rachitis in the fetus undoubtedly is the commonest cause of intra-uterine fractures, which are commonly multiple. Tibial fractures are frequently associated with an imperfect development of the long bones. The intra-uterine conditions are not favorable to a good union. Union may take place before birth, but usually it is a union with bad deformity. In rachitic fetuses the conditions for good union are particularly unfavorable. If these fractures remain ununited, or if they have healed, but have produced marked dislocations, they may cause difficult labor.

Congenital luxations occur in certain joints, and produce such secondary changes on the surface of the joint that in some cases restoration at the time of birth is impossible. Various joints may thus be affected, but this accident occurs most frequently in the hip-joint. In Prof. Langenbeck's clinic there occurred 90 cases of luxation of the hip-joint to 5 of the humerus, 2 of the head of the radius, and 1 of the knee. According to Krönlein, luxations are more common on one side. Luxations are apt to be associated with other malformations; they are commoner in females than in males, 87.6 per cent. occurring in females.

Etiology of Dislocations.—As to the etiology, many theories have been advanced to account for the occurrence of dislocations, of which the following four are the most plausible:

1. That it is due to true traumatic dislocation resulting from injury inflicted before birth or during delivery.

2. That it depends on a relaxed condition of the ligaments or upon hydrops of the joints.

3. That it is a deformity caused by spasmodic muscular contractions during fetal life.

4. That it is due to a malformation of the acetabulum characterized by the production of deficiency of the socket in which it is normally held.

Since in most cases of congenital dislocation the labor has been easy and natural, the first theory will hardly hold. It has also been demonstrated (Müller) that the same force which in an adult would produce a dislocation will in the fetus produce epiphyseal separation. The theory accepted by most writers as the most plausible explanation for the cases which have been examined is the fourth—congenital malformation of the acetabulum. This theory, which was advanced by Paletta, has found adherents in Dupuytren, Brechet, and most recent writers. The deformity is not usually noticed until it is time for the child to walk. The affected limb is slightly shortened. As the child grows older obliquity of the pelvis and compensatory lateral curvature of the spine may follow. Further discussion as to symptoms and treatment would hardly come within the scope of this work.

Congenital Tumors.—*Abdominal Tumors.*—The fetus occasionally presents at birth abdominal tumors of considerable size. The abdomen may be enlarged on account of ascites, which is usually of syphilitic origin. Distention of the bladder sometimes produces an immense enlargement. Other abdominal enlargements which have been observed are produced by hydronephrosis, dilated ureters, ovarian tumors, and carcinoma of the liver.

Sacral Tumors.—Various tumors also occur on the surface of the body, particularly in the sacral region. They may be located on the sacrum or on the sacrum and coccyx, but usually on the coccyx alone. They are more frequent in the female than in the male. Out of 58 cases of sacral tumors, forty-four were females, fourteen males (Molk.)

The tumors vary in size and in their general appearance. We distinguish the following forms: (1) Congenital cystic tumors; (2) Congenital fatty and fibrous tumors; (3) Congenital tumors with fetal remains; (4) Caudal excrescences; (5) Attached fetuses.

The *cystic tumors* are usually hydrencephalocele or spina bifida. They occur chiefly in the cervical and lumbar regions. Fibrous tumors and lipoma occasionally occur. Sometimes these tumors contain a part or parts of a fetus. This inclusion results from a cleft in the medullary fold, that may give rise to a double formation resulting in a rudimentary tumor. These tumors may be simple or be multilocular; they may contain rudimentary limbs, cartilage, or loops of intestine. Sometimes one rudimentary fetus is attached to the palate of a fetus more developed. *Caudal appendages* occasionally occur: they may be either fibrous or bony, assuming the shape of a tail. Molk gives two such examples. Sometimes in cases of *attached fetuses* an extra limb is attached to the sacro-lumbar region; sometimes it consists of two limbs fused into one (see *Dystocia*). In these cases the pelvis usually shows some malformation.

Treatment of Congenital Tumors.—Of all these tumors the treatment is excision, but it is only indicated in cases where the attachment is not too extensive or where the growth does not to any extent encroach on the pelvic cavity or the viscera.

Deformities of Special Regions and Organs of the Body.—The influence of amniotic bands in arresting development by preventing the normal fusion at an early stage of embryonic life is now generally admitted as an explanation for such deformities as hare-lip, cleft palate, fissure of the nose, etc. Often a number of malformations occur in the same individual.

Deformities of the Face.—If the frontal process fails to unite with the superior maxillary process, which in the normal course of development unite in front of the mandibular tissues, a defect in the soft parts, producing hare-lip, may result; if the inward growth of the palatine processes is arrested, cleft palate results.

Hare-lip occurs in various degrees. Sometimes there is only a slight notch in the lip, and again there may be one or two fissures extending to the nostril, and it may or may not be associated with cleft palate. The existence of hare-lip interferes more or less with nursing, especially if associated with cleft palate. Often feeding with a spoon is unsatisfactory, because the food will regurgitate through the nose. Infants with hare-lip, as a rule, are therefore imperfectly nourished, and if they survive are likely to possess a low vitality. *The treatment* consists in sustaining the strength of the child as well as possible for the first few weeks of life; after that an operation should be performed. A consideration of the methods of operating would hardly be within the scope of this work.

Congenital occlusion of the posterior nares occurs, but very rarely. Congenital cysts of the floor of the mouth sometimes manifest themselves in the form of a swelling under the tongue or the chin.

Tongue-tie.—Very frequently the frenum of the tongue binds this organ to the floor of the mouth, immobilizing the tip of the tongue more or less. This condition interferes with suckling, and if not corrected will prove an impediment to speech. *The treatment* consists in operating, as soon as the discovery is made, by raising the tongue either with a spatula or a finger, rendering the frenum tense, snipping the membrane with scissors, and making any further separation by tearing with the finger. Care must be taken not to cut too deeply, to avoid profuse hemorrhage.

In the second part of the digestive tract strictures or pouches may occur.

Malformations of the stomach are not common. The "hour-glass" deformity sometimes occurs. Congenital obstruction of the bowel may be located in the duodenum or the jejunum, but more frequently in the ileum. Portions of the intestine may entirely be absent, or be represented only by a band of fibrous structure running along the free edge of the mesentery. Volvulus and hernia may cause obstruction.

Congenital inguinal hernia is due to a patulous condition of the inguinal canal, through which a loop of intestine protrudes.

A few cases of perforation of the intestine are recorded. In these cases death occurred within the first few hours after birth. In three cases the rupture was found at the sigmoid flexure; in one case in the splenic flexure; in one case the transverse colon was perforated. The *etiology* is tissue-necrosis, probably accumulation of meconium.

The large intestine, including the sigmoid flexure and the rectum, is liable to various malformations. The commonest malformation is obstruction of the bowel, due to deficient development. In an imperforate rectum there may be a well-defined exterior opening or it may be absent; the rectum is usually deficient to a greater or lesser degree. In imperforate anus the rectum is well developed, but the external opening is lacking. In some of these cases where the anus is absent the rectum passes into the anterior or genito-urinary segment.

Hydrocele is a not infrequent affection, and is dependent somewhat upon congenital deformity when the processus vaginalis remains patent.

Congenital defects in the generative organs of female children are not so common as they are in the male, and they are frequently not noticed until a later period in life. The defects of the internal organs are gynatresia and defect of the uterus and of the ovaries. Malformations of the organs of generation of the female are usually due either to absence of Müller's ducts, to failure of union or bicornuity, complete or partial, or to persistence of the septum, giving rise to the double formation of uterus and vagina. Persistence of the canals of Gärtner sometimes gives rise, later in life, to cysts of the vagina, and persistence of the ducts of the Wolffian body may develop into parovarian cysts.

Numerous cases of cystic tumors of the ovaries existing at birth have been recorded, but there are still controversies concerning the embryonic origin of these tumors, some assuming that all cystic ovarian tumors are already formed in the embryo (Pozzi). This origin applies especially to the dermoid. J. Bland Sutton, who has devoted much time to the study of fetal ovaries, says: "I have never succeeded in detecting an ovarian dermoid at birth, neither can I refer the reader to a trustworthy case."

Malformations of the Extremities.—Numerical excess, supernumerary digits or toes, is another variety of malformations. The *treatment* for supernumerary digits is amputation. Congenital union of digits (syndactylism) occurs in varying degrees, there being sometimes a firm fusion of the two adjacent members, at other times a webbed condition. The fusions are *treated* by incision.

Club-foot is only a modification of a physiological position *in utero*. Too small an amount of amniotic fluid tends to produce club-foot, the foot being pressed against the breech; this long-continued pressure of the soft parts tends to shortening of the bones by retarding the progress of growth; thus the position becomes fixed (Landerer). This congenital malformation usually produces talipes varus or equino-varus. There is usually more or less paresis, and sometimes paralysis of the muscles of the affected side and tonic contraction of their opponents. The *treatment* consists in proper bandages, which should be applied as soon as the deformity is discovered.

Malformations of the Circulatory Apparatus.—Malformations of the heart are very common, especially persistence of the foramen ovale. Fetal endocarditis, with its consequent valvular lesions and transposition of the aorta and pulmonary artery, also occurs. Sometimes there is but a rudimentary septum between the ventricles. As this system resembles the arrangement of the heart of the lower forms of life, it is called "reptilian heart." Persistent cyanosis is the most marked symptom of these malformations. Frequently the fetus is not viable.

Malformations of the Brain and Cord.—*Cerebral hernia*, or *meningocele*, is a tumor varying in size from a hazel-nut to that of a child's head. It occurs usually on the occiput, occasionally at the root of the nose or on one of the fontanelles.

Spina bifida, which is not uncommon, may occupy any part of the length of the spinal column. It is a congenital malformation in which the laminæ fail to unite in one or more of the vertebræ, allowing protrusion of a sac composed of the spinal cord or its membranes. If the spinal membrane only protrudes, it forms spinal meningocele; if the cord and spinal nerves as well as the membranes protrude, they form meningo-myelocele; if in the latter protrusion the spinal canal is dilated, forming a sac, it forms syringo-myelocele.

Exencephalus is a deformity in which the brain is present, but the cranial bones are not developed. *Pseudencephalus*, in which the bones of the cranium are absent or are undeveloped and contain a rudimentary brain, is a more common deformity than *anencephalus*, in which there is no brain and no development of the cranium. *Acephalia* and *hemicephalia* are deformities consisting in a defect of the skull; sometimes the defect continues into the spine. The integument and nerve-tissue are wanting, and are replaced by some granulation tissue. The *etiology* is unsettled, although several theories exist. A fetus with this malformation is usually not viable; if there is life at the time of birth, it soon ceases. These deformities may occur successively in several pregnancies. *Microcephalia* is a monstrosity with a very small skull. The forehead is flattened and receding. Monstrosities of this class may be viable; if so, they are imbecile. They may live for some time, and may even attain great age.

Excessive Development.—Excessive development of the whole fetus occasionally occurs, in which the fetus has weighed from fourteen to eighteen pounds (A. Martin, Beach, Meadows); the more frequent cause, when the excessive development is not very great, is prolongation of pregnancy; other causes are multiparity and excessive size of one or both parents; again, there are cases in which the fetus as a whole does not exceed in weight the normal limits, but there is an excess of development in some particular member of the body, especially one of the extremities. In such hypertrophies of the fingers and toes, if the deformity is sufficiently pronounced to prove a hindrance, amputation is indicated.

FIG. 162.—Thoracopagus (double formation).

Double Formations.—Authorities do not yet fully agree concerning the cause of formation of homologous twins and double monsters. It is generally accepted that both originate from one blastula of the yolk. It is still a question of dispute whether the blastoderm membrane presents two germinative areas, which later fuse more or less into one being, or one area, which becomes more or less divided.

As union may take place in the cephalic, the median, or the caudal extremity of the embryo, one of these forms of monstrosities may result (Müller). They are accordingly named cephalopagus, thoracopagus, ischiopagus, etc. Of these classes various modifications occur. Figure 162 represents an interesting specimen of thoracopagus, exhibited by Dr. W. W. Jaggard before the Gynecological Society of Chicago. If there is an unequal development of the embryos, one may seem nearly normal, while the other is quite rudimentary and seems to form but an appendage to the former. Such a rudimentary fetus may even become completely enclosed by the larger one (Müller).

4. MATERNAL IMPRESSIONS.—There exists a popular belief, which was particularly prevalent during early times, that the peculiar sensations, emotions, sights, etc. experienced by a pregnant woman are frequently transmitted to her child, and if these sights and impressions are particularly frightful, they cause marks and defects on the child. One of the arguments

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advanced in favor of this view is that a belief so universal and adhered to through centuries is rarely entirely fallacious, especially when the subject is based upon observation. The advocates of this theory adduce one of their most reliable arguments from the Scriptures (Gen. xxx. 37–39): "Jacob took him rods of green poplar, and of the hazel and chestnut tree; . . . . And he set the rods which he had pilled before the flocks in the gutters in the watering-troughs, ... that they should conceive when they came to drink. And the flocks conceived . . . . and brought forth cattle ringstraked, speckled, and spotted."

At the present time authors, practitioners, and teachers differ, but up to the beginning of the eighteenth century they were nearly unanimous in the belief that fetal marks, deformities, and lack of development were due to impressions received by the mother. Wherever the truth may lie, it is very evident that many of the cases cited have been taken from individuals whose testimony would hardly pass as conclusive in other matters.

During the past forty years many articles have been written strongly opposed to the previously accepted theory of maternal impressions. It has always been extremely difficult to demonstrate that any deformity or mark or lack of development in the child was due to an impression which the mother may have received before its birth, inasmuch as there seems to be at least one unanswerable argument in that we find no direct nerve-connection existing between mother and child.

The late Fordyce Barker has been credited with demonstrating the correctness of the theory of "maternal impressions" in a paper read in 1886 before the American Gynecological Society. He quotes freely from physiologists to show that the weight of authority must be conceded to be in favor of the doctrine that maternal impressions may affect the growth, form, and character of the fetus. His opinions, however, were very largely based upon references and arguments adduced from older writers. Barker, in concluding, quotes the following from the *British-American Journal:* "When, in the early weeks, structural development is proceeding at no tardy rate, an interference to nutrition of the mother cannot but impress the fetus detrimentally, and the organ interfered with would be that one in the condition of the most active development, or that which could less easily bear any arrest, however transient, with impunity." Again: "Then, too, although no nervous connection has been demonstrated to exist between the mother and the fetus, yet the latter possesses nerves; and alterations of the nutrient power of the mother cannot but act on the nerves that are governing, though it may be only to a slight extent, the growth of the fetus itself." As a matter of fact, only a few cases —exceedingly few—of defective or marked children are born compared with the multitudes of perfect ones; then, too, the testimony in many of these cases is absolutely worthless.

One of the ablest articles opposing this theory is written by J. G. Fischer. A few of his conclusions, and those epitomized, will be given. They are briefly as follows: That traditional superstition has perpetuated the notion, and that the medical profession is in no considerable degree responsible for its continuance; that intense emotions and apprehensions are experienced, and malformations are expected by many gestating women, yet the abnormal births are extremely rare; that there is no law in the alleged result, and that the occasional apparent relation of cause and effect is due to accidental coincidences.

There is, in addition, against the theory, another argument, which is that the assumed causes are alleged to have operated upon the embryo subsequently to the named period for the evolution of the part which is found to be the site of the malformation, implying not only a formative process, but a retro-formative power. This argument, it appears to the writer, is particularly strong. For instance: a child is born with a profuse growth of hair upon a spot of the body where it should not exist. The mother and her friends, after considerable coaching, remember that some of the impressions somewhat similar to this were received at a certain time. As a matter of fact, that time occurred a considerable period after or before the period when, according to the study of embryology, we know the hair to have been developed.

Several years ago Norman Bridge wrote a strong paper against the theory. Among other things, he says: "To endow the blood with such a weird intelligence as this would require is too great a load for our credulity. There is no philosophy that it so acts. There is possibly enough in this theory so that we should, on account of the comfort of the pregnant woman, advise her not to indulge in violent emotions, or to see peculiar sights, or to do anything which is outside of the proprieties of life." It is desirable, in the writer's judgment, to give this advice to all pregnant women.

Many cases have been brought forward that seem almost to prove the position assumed by both parties in this controversy. In the writer's judgment, nothing is really established, and we must continue to believe that if a pregnant woman sees a sight and gives birth to a marked baby, it is usually only a coincidence. We must still regard the relation of cause and effect as largely an accidental coincidence bearing in mind, however, the fact that, exceptionally, very profound emotion can and does in some unknown manner influence the growth and development of the fetus.

5. Intra-uterine Diseases of the Bones.—*Rachitis* of the new-born occurs in two distinct forms—the fetal and the congenital. Although rachitis as it occurs in early childhood was recognized by the ancients, it is only recently that the existence of the fetal form has been fully recognized and described. Since Bohn and Winckel described these two forms the investigations of Virchow, H. Müller, and others have given support to this classification. Both forms originate in the pre-natal state, but in the fetal form the disease-process is fully developed at birth; in the congenital form it continues to develop.

Fetal rachitis (Fig. 163) has been characterized as a disease of the periosteal cartilage, giving rise to an active growth in the wrong direction; at the same time there is a deficiency in the deposit of calcareous matter. In rachitis the cartilaginous and subperiosteal cell-growth is excessive and irregular, while the process of ossification itself is also irregular and sometimes wanting

(Fig. 164). The line of ossification between the epiphyses and diaphyses is irregular, likewise is the zone of calcification; newly-formed bone- and marrow-cavities may be in the midst of cartilage, and masses of cartilage may take the place of bony tissue. At the same time there is an excessive proliferation of cells on the inner layer of the periosteum; these various abnormal processes lead to bony deformities. The long bones develop more laterally than longitudinally; the extremities are short, thick, and usually curved; the skull-bones are thick; the ribs show nodular enlargement (beaded ribs); deformities occur in the spinal column and pelvis, and the thorax shows the "pigeon breast." There is a general disproportion between different parts of the body. The head is often large, the neck thick and short, the abdomen large. Associated with these characteristics we may find hydrocephalus and enlargement of the thyroid gland.

Reference has already been made (page 300) to the frequent occurrence of intrauterine fractures in cases of congenital rachitis.

There are other conditions which affect the growth of the skeleton *in utero*, and which resemble rachitis—Schmidt's, Bidder's, and Müller's diseases.

Bidder's Disease.—In Bidder's disease (osteogenesis imperfecta) the lines of ossification are normal; the epiphyseal cartilage is normal, but

Fig. 163.—Fetal rachitis.

Fig. 164.—Skull (front view) in fetal rachitis; absence of frontal bone.

ossification does not fully take place either in the epiphysis or in the diaphysis. The bone-production from the periosteum is commenced, but in the diaphysis the compact portion is imperfectly developed; in the marrow-cavities there is no deposit of calcareous substance. The bones remain short and pliable; the sagittal suture remains broad. The bones of the face and skull are particularly apt to be affected. Sometimes this condition affects in a slight degree the bones of the skulls of infants who are otherwise perfectly developed.

Schmidt's disease is characterized by great predisposition to fracture of the bones. The periosteum and the epiphyseal cartilages are normal, but the bony canulæ do not present the concentric arrangement which normally exists.

The bone-corpuscles are large, and usually remain empty. The spongy substance contains much connective tissue and many undeveloped cells.

Müller's disease is a diseased condition of the cartilage. The embryonic development of cartilage, which normally extends chiefly in a longitudinal direction, expands in all directions; at the same time the development of bony structure from the periosteum continues. This action leads to the production of thick, short bones. The skull-bones are also very thick.

6. Intra-uterine Diseases of the Skin, Connective Tissue, and Serous Membrane.—Diseases of the skin, the connective tissue, and the serous membrane that manifest themselves in the pre-natal state are usually due to fetal syphilis. Cases of congenital ichthyosis, pemphigus, and other eruptive diseases have also been observed.

Pemphigus.—Pemphigus neonatorum in its epidemic form is considered on another page; it must not be confounded with the congenital form. Although the pemphigus is usually syphilitic when present at birth (Roeser says always), still some cases of non-syphilitic pemphigus have been observed. Erysipelas has been observed to be transmitted to the fetus *in utero*.

Anasarca.—Under this head belong hydrothorax, ascites, and hydrocephalus. These conditions often produce mechanical obstruction to delivery. Occasionally anasarca is seen in connection with dropsy of the mother. This condition is frequently due to obstruction of the umbilical vein accompanying syphilis. Excessive distention of the body may result from ascites and hydrothorax. Ascites is often due to syphilis; also to organic lesions of the heart.

Tumors.—Among congenital tumors of the skin, nevus is the most common. Although not always noticed at the time of birth, the nevus is probably always present at that time. These tumors belong to the angiomata. Hairy and pigmented moles often occur congenitally.

Peritonitis.—Fetal peritonitis is usually due to syphilis. It manifests no symptoms at this period, but if not destructive to the life of the fetus, it is likely to produce some constriction of the bowel. It also occurs in infants in connection with puerperal fever, especially in lying-in hospitals. The pathological conditions correspond with those found in similar cases in adults.

Pericardial and endocardial inflammations rarely occur, and the latter is more often located in the right side of the heart, and may leave lasting valvular changes.

7. Struma.—Struma of the thyroid gland must not be confounded with edema of that structure. While edema occurs as a traumatic injury, true struma is an hypertrophy of the thyroid. Edema results from face presentation; hypertrophy may produce the same. Struma may be complicated with edema, which, however, will only be temporary.

8. Intra-uterine Diseases of the Nervous System.—There are of the brain a number of defects which are congenital in their origin, and which later manifest themselves as some forms of deaf-mutism, cretinism, idiocy, and other forms of partial or complete loss of development. Hypertrophy of the brain sometimes occurs, associated with rachitis.

Hydrocephalus.—Fetal hydrocephalus is not common and its etiology is not understood. According to Meigs, it is due to an inflammation of the lining of the ventricles. It often produces a hideous deformity, due to protrusion of the eyes and projection of the forehead (see page 259).

Cretinism is endemic in some mountainous districts of Europe. It is often associated with enlargement of the thyroid gland.

Syphilitic Idiocy.—Manifestations of syphilitic idiocy are recognized after the period of infancy.

9. DEATH OF THE FETUS.—In presenting this subject a repetition of what has been said under *Abortion* (page 259) can hardly be avoided.

The causes resulting in death of the fetus before maturity may be considered under the following heads:

(1) In the father,—alterations of semen, as in phthisis, albuminuria, etc.

(2) In the mother,—general diseases, excitability of the uterus, and marked lesions of the same.

(3) In the fetus—or faulty development.

(4) In the annexes of the fetus—membranes, placenta, cord.

(5) External violence.

(1) *Causes resulting from the Father.*—Conditions producing great debility in the father are liable to manfest themselves in a low degree of vitality in the offspring, and often before the time of birth produce death in the embryo. Old age in the father, chronic poisoning, albuminuria, and phthisis are likely to be followed by this result, but the most frequent cause from the parental side is the transmission of syphilis from the father. The embryo may show signs of this disease without the mother being infected.

Death of the fetus is explained in various ways. The fetus itself may be of low vitality, or the membranes may become affected in a way to interrupt life. Syphilis may produce hypertrophy of the villi of the chorion (Schroeder), producing sufficient pressure on the maternal vessels to render imperfect the interchange of nutrition between mother and fetus. The more recent the infection of the parent the more likely is it to produce death of the fetus and abortion. Rupture of one of the viscera may cause death of the fetus. J. W. Ballantyne cites three cases in which rupture of the spleen was the immediate cause of death within two days of delivery. One case occurred during Prof. A. R. Simpson's service, and the post-mortem examination was made by the writer; death occurred two days after labor. The second case is one reported by Charcot (1858), in which a stillborn infant had been resuscitated and lived half an hour. The third case was reported by Kleinwächter (1872): a prematurely born infant, weighing four and a half pounds died in four hours.

2. *Causes resulting from the Mother.*—The influences from the mother leading to death of the fetus are numerous. Acute infectious diseases of the mother come under this head. It has been demonstrated that high temperature and anemia of the mother are liable to interrupt gestation by premature uterine contraction. Tuberculosis, carcinoma, nephritis, and diabetes of the mother often cause peculiar excitability of the embryo; the nervous system of the

mother will likewise bring about this condition, the motor nerves responding to very slight irritation and setting up uterine contraction. Phthisis of the mother sometimes produces premature labor, sometimes abortion. Death of the fetus on account of tuberculosis of the mother is not usual, but frequently the child is poorly developed, and if it survives remains feeble. Whether this feeble condition is due to lack of resistance or to intra-uterine or latent disease cannot now be decided.

Conditions of the uterus and its immediate surroundings may interrupt pregnancy; especially is this true of endometritis and all inflammatory conditions of the parenchyma. Conditions which interfere with the expansion of the uterus, such as versions, flexions and adhesions, and neoplasms, also sometimes interrupt pregnancy, but usually the uterus overcomes the resistance by degrees. The presence of uterine fibroids is more likely to interfere.

3. *Causes resulting from Faulty Development of the Fetus.*—As regards the fetus itself, anasarca sometimes results from disease of the mother, sometimes independent of the same; it may cause premature birth and expulsion.

4. *The Annexes of the Fetus.*—Membranes, placenta, and cord, degenerations of the placental villi, extravasations and effusions of blood into the placenta and membranes, will more or less interfere with the nutrition of the embryo, causing partial or complete separation of the placenta. Amyloid and fatty degenerations of the placenta will produce the same result; likewise any condition which interrupts the circulation of the cord must be disastrous to the nutrition, and eventually to the life, of the fetus.

Dropsy of the amnion (hydramnion), or an excessive amount of fluid in the amniotic cavity, is not uncommon. When it exists in a marked degree, it will produce death of the fetus, though the latter may have advanced to maturity. Knots in the umbilical cord may produce sufficient change in the circulation to materially affect the fetus (Fig. 165). Lefour, who experimented with reference to knots of the umbilical cord on the fetus, concludes that "the influence of mere knots apart from compression is slight. When the intravascular compression increases the cord becomes turgescent and tends to loosen."

FIG. 165.—Knotted cord (Bidloo).

When death of the fetus occurs in successive pregnancies the term "habitual death" is applied. Some authors apply the term only to those cases in which abortion occurs repeatedly at the same stage of pregnancy. Schroeder would apply the term only to cases occurring repeatedly at about the same period and associated with no apparent anatomical changes in the mother, the embryo, or the membranes—that is, when the interruption is brought about merely through excessive irritability on the part of the mother. Most authors, however, give as causes for habitual death of the fetus, first, syphilis, the most common, then maternal anemia and uterine disease.

5. *External Violence.*—The differential diagnosis between death produced by external violence and that produced by natural causes is of medico-legal interest, but does not properly belong to this work.

10. Post-mortem Changes of the Fetus in Utero.—The changes produced in the fetus by pre-natal death are characteristic, and usually are markedly different from those produced after birth. A number of post-mortem changes may take place; in the main, the changes vary somewhat with the period of development. If pregnancy is interrupted during the first few weeks, the embryo is usually not much altered, is small, and is generally surrounded by very little fluid.

If the fetus dies during the first months of gestation and the ovum is not expelled, some weeks afterward the latter may be found containing no trace of the embryo. The total absorption of the fetus assumed by many writers is doubtful; according to Müller, it does not occur frequently, and probably is possible only at a very early period of development. He assumes that in many cases where no trace of the fetus is found it has either passed previous to the expulsion of the membranes, or has been liquefied and is passed in a state of dissolution. The membranes may show signs of decomposition or may contain extravasations of blood. If the vitality of the chorion has been retained for several weeks or months, it will result in a "mole pregnancy."

After the fourth month of gestation the possibility of unobserved escape of the fetus or that of liquefaction no longer exists. At this period the fetus is either retained without change or it undergoes one of the following changes: 1. Maceration; 2. Saponification; 3. Mummification; 4. Putrefaction; 5. Suppuration; 6. Calcification.

Maceration (Fœtus sanguinolentus, E. Martin) is the most common of the post-mortem changes of the fetus after the fifth month; it rarely occurs at an earlier period of development. The fetus is usually discolored, brownish, and livid; some of the epidermis shows bullæ; these may contain a yellowish fluid, or if ruptured the red corium is exposed. The thoracic cavity is usually small, the abdomen large, containing bloody fluid, and all tissues, muscles, and bones are softened. The umbilical cord is dark, and Wharton's jelly is distributed irregularly. The placenta is also softened and saturated with bloody serum; the chorion and decidua show necrosis. In some cases occur the characteristic changes of syphilis, osteo-chondritis syphilitica being especially marked in the lower epiphysis of the femur. Associated with this may be a condition designated by Buhl "lipoid degeneration." Literature contains but one case of this change, it being fully described by Buhl. In this case the muscular, adipose, and bony structures were unchanged, but the cavities were lined with a thick caseous matter, which in microscopic examination showed crystals of margarin. According to Buhl, this process must not be confounded with that of "saponification."

Saponification.—The process of "saponification," described in older books, comes probably under the head of mummification.

Mummification.—This change may be regarded as the typical post-mortem change of the fetus when death takes place between the third and the sixth month. The fetus is shrivelled, the tissues are dried, the skin is gray and shows the outline of the skeleton. If such a fetus has been retained for a long period and is subjected to pressure, it sometimes becomes desiccated and flattened like a sheet; such a change is designated by the term *fetus papyraceus.* Twin pregnancy is most likely to produce such a change when one embryo dies and the other continues to live and develop. The placenta is also dehydrated, and there is no amniotic fluid. This fluid has either been drained off or has been absorbed by the chorion. Mummification is more likely to occur in cases where the cord is twisted about the neck of the fetus. If the fetus attains the age of several months before death takes place, it is likely to undergo one of the two changes, putrefaction or suppuration. Both these changes are due to the entrance of germs, which is more liable to occur after the rupture of the membranes, so that germs are admitted from without.

Putrefaction.—The process of putrefaction differs from that of maceration. It is characterized by the presence of a foul odor and by the production of gas—sometimes in great amount (physometra or tympanites uteri).

Suppuration is often associated with putrefaction. The changes which the fetus undergoes in ectopic gestation have been referred to under that head.

Calcification.—A dead fetus remaining in the uterus or in extra-uterine cysts for a longer period may become infiltrated with calcareous matter until it resembles a stone. Such a fetus is termed a *lithopedion* (p. 283). Cases are on record where the fetus has been retained in this state for many years. Lusk cites a case in which the woman was supposed to be pregnant, and labor ceased with the expulsion of a child. Thirteen years later Lusk removed a calcified fetus.

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III. LABOR.

I. THE PHYSIOLOGY OF LABOR.*

Definitions.—Labor is the complex process by which the ovum is severed from its connection with the mother and extruded or extracted from the maternal organism. The term *normal labor* (eutocia) may be restricted to labors with normal factors that are terminated by the natural forces, or it may be narrowed down to include only vertex presentations in anterior positions under right conditions. *Dystocia,* or difficult labor, includes all forms of abnormal or complicated deliveries near term. *Premature labor* refers to the premature birth of a fetus which has reached the period of viability or of sufficient development to live independently of the mother. *Miscarriage,* or immature delivery, is usually restricted to the expulsion of the fetus from the third month until viability, although it is often used as a synonym of *abortion,* and is the lay term for that event, "abortion" to the layman denoting criminal intent. The word abortion is reserved for the expulsion of the ovum in the first three months.

Causes of Onset of Labor.—What constitutes maturity or ripeness we do not know, and in the indefiniteness of our knowledge "we refer the matter to a law of the organism—a law the cause of which we do not know."

The termination of pregnancy is due to some combination of conditions, no one of which, singly, will account for the occurrence of labor at two hundred and eighty days after the date of appearance of the last menstrual period. Briefly stated, the chief factors are—

1. Increasing irritability, with strengthening intermittent contractions.
2. Changes in the decidua—loosening, thinning, and thrombosis.
3. Excess of CO_2 and lessened oxygen in the placental blood acting on the motor centre for the uterus in the medulla.
4. Increasing tension on fully-developed muscular walls.
5. Stronger fetal movements in more confined space.
6. Partial relaxation of the cervix.
7. Menstrual periodicity (tenth period).
8. Habit and heredity.
9. Exciting cause—exercise, strain, emotion.

1. A steadily increasing irritability is probably the rule during gestation. At certain menstrual epochs, such as the second, third, and seventh, it is especially marked, and there is evident disturbance both of the neighboring nerves and of uterine ganglia in the first and last trimesters.

Intermittent contractions occur regularly in the non-gravid uterus, they

* The *superior* figures ([1]) occurring throughout the text of this section refer to the bibliography given on page 340.

are distinct from the very beginning of pregnancy, they steadily gain in strength during its progress, and at its end hardening and prominence during contractions may always be found. The dividing-line between contractions and true labor-pains is not easily drawn, and as soon as the ovum becomes a foreign body by beginning separation more vigorous action is ensured.

2. The changes in the decidua are well epitomized by Lusk:[1] "The researches of Friedländer, Kundrat, Engelmann, and Leopold have demonstrated that the decidua vera of pregnancy is distinguishable into an outer dense, membranous stratum, composed of large cells resembling pavement epithelia, probably metamorphosed cylindrical cells, and an—in appearance—underlying meshwork, formed from the walls of the enlarged decidual glands. It is in this spongy layer that the separation of the decidua takes place, the fundi of the glands persisting even after the expulsion of the ovum. By many a fatty degeneration of the cells of the decidua has been observed toward the end of pregnancy, but Leopold, Dohrn, and Langhans have shown that this is not of constant occurrence. The trabeculæ which enclose the spaces of the network diminish in size with the advance of pregnancy. Thus, while they measure at the fourth month about $\frac{1}{500}$ of an inch in thickness, they become gradually reduced in the subsequent months to $\frac{1}{2500}$ of an inch—a change which materially facilitates the peeling off of the decidual surface.

"From the fourth month onward large-sized cells make their appearance in the serotina, especially in the neighborhood of thin-walled vessels. The largest of the so-called giant-cells contain sometimes as many as forty nuclei. Though a physiological product, they resemble for the most part the so-called specific cancer-cells of the older writers. They are of special obstetrical interest from the fact, observed by Friedländer and confirmed by Leopold,[2] that they penetrate the uterine sinuses from the eighth month, and lead to coagulation of the blood and to the formation of young connective tissue, by means of which a portion of the venous sinuses becomes obliterated before labor begins. The subtraction of these vessels from the circulation tends to increase the amount of the venous blood in the intervillous spaces of the placenta."

3. Brown-Séquard found by experiment that an excess of CO_2 circulating in the blood of a gravid animal excited uterine contractions, and he claimed that this excess of the gas was the proximate cause of labor. His theory lacks conclusiveness, however, because it does not explain why the CO_2 postpones its irritant action until the end of the ninth month. Leopold believes that the excess of CO_2 in the placental blood is the result of venous hyperemia of the placenta, produced by the spontaneous thrombosis in the veins of the placental site at the end of pregnancy, while Hasse credits it to certain changes in the circulation of the fetus—chiefly in the crossing blood-currents of the right auricle and shrinkage of the ductus venosus and arteriosus. Spiegelberg teaches that at maturity the fetus requires some new substance not supplied by the placenta, and that it dies (as in extra-uterine pregnancy) if it does not obtain it, while chemical substances no longer required accumulate in the blood and act as irritants to the special nervous centres.

4. Power in 1819 called especial attention to over-distention of the uterus as a causative factor in labor; it can admirably be demonstrated by analogy. As the over-loaded stomach or the rectum rejects its burden, so the over-distended uterus rebels and expels its contents by the contractions of labor when the mouth of the organ begins to be distended. The occurrence of premature labor in hydramnion and multiple pregnancy sustains this theory, but, on the other hand, it does not account for labor-pains in extra-uterine pregnancy. The extensibility of the uterine wall has a limit, and when this is reached the ovum in its growth presses more and more upon the internal os. This pressure excites a special set of nerves and brings about uterine contractions, just as the contact of the drop of urine at the neck of the distended urinary bladder excites contraction and evacuation of that organ.

A theory of this nature brings up the question of the innervation of the uterus. Through what set or sets of nerves does the uterus receive its motor impulses during labor? The nerve-supply is largely from the hypogastric and ovarian plexuses of the sympathetic system. The cervical ganglion receives, in addition to its extensive connections with the sympathetic, filaments from the second, third, and fourth sacral nerves. But Lusk and Jacquemart report cases of successful labor in patients suffering with paralysis of the lower extremities, retention of urine, and incontinence of feces—a state of affairs which would lead one to discount the importance of the *rôle* played by the filaments from the sacral nerves. On the other hand, the experiments of Schlesinger[3] argue against the exclusive source of motor-supply resting with the sympathetic, for he was able to elicit reflex movements of the uterus by stimulation after severing all the branches of the aortic plexus. Whether he may not have overlooked some of the slender nerve-filaments in cutting the branches of the aortic plexus is a question worthy of consideration, and the possibility of such an error detracts from the value of his experiments and the weight of the conclusions to be drawn from them. The uterine ganglia have a certain independence of action, such as the cardiac ganglia possess, since rhythmic contractions by both may be kept up after separation.[4] Brandt has shown that massage of no part of the pelvic contents will produce contraction in the non-gravid uterus so rapidly as manipulation of the (supravaginal) cervix, and the writer has demonstrated this for the early weeks of pregnancy.[5]

Whatever the channels of nerve-force may be, there has been proved to exist in the medulla oblongata a motor centre for contraction of the uterus that may be excited to action by CO_2 in the blood, by anemia, and perhaps by the toxic substances retained in the blood of one suffering from nephritis. At full term something stimulates this centre to activity, with a complex, co-ordinated set of muscular contractions as the resultant. Moreover, it is supposed by Schatz that the uterus possesses an inhibitory centre which is active throughout pregnancy, but which for some reason ceases to act at term.

6. A diminished resistance in the lower birth-canal is to be noted. The cervix is fully softened, the pelvic floor is edematous and relaxed, and the uterus and its contents often sink low in the pelvis.

7. The theory advanced by Tyler Smith to the effect that the tenth period of ovarian excitement incites the nervous apparatus of the uterus to activity is of some force, since pregnancy is often interrupted at menstrual epochs; but it is open to the same objection as that just mentioned, for it does not make plain why the ninth or eleventh period fails to effect the same result. Moreover, single ovariotomy has been performed many times, and double ovariotomy a few times, during pregnancy, without perceptibly influencing its course.

8. Many multiparæ follow the same rule in a series of pregnancies. In other cases great variations are seen.

9. Finally, with all things ready, an unimportant, perhaps accidental, occurrence, such as slight increase in intra-abdominal pressure from walking, stair-climbing, coughing, or straining at stool, as well as any mental irritation (anxiety, care, anger), may be the exciting cause.

We have been dealing, then, with determining causes, factors in a phenomenon, none of which can establish a claim to be considered singly and absolutely causative. Winckel sums up by saying that labor is the total of several causes which may enter into different combinations to accomplish the same result. Lusk takes substantially the same ground, and Barnes observes that the determining causes act synergetically, not singly.

The fetus is mature, ready to undertake the complex acts of respiration and digestion; the imperceptible uterine contractions of several weeks have loosened the attachments of the decidua, whose trabeculæ have grown much thinner and capable of easy rupture; the uterus by distention, perhaps by increasing pressure of the fetus on the internal os, has grown very irritable, the lusty inmate augmenting this condition by the force and frequency of its movements. The maternal blood contains an increased quantity of CO_2; venous thromboses in the uterine wall near the serotina and in the serotina itself obstruct the circulation and cause stasis of the maternal blood returning from the placenta; the cervix uteri becomes soft and dilatable; the advent of the tenth menstrual date, with increased congestion and irritability of all the generative organs as a consequence, adds fuel to the pile; the unknown factor deposits the spark at the centre of uterine contraction in the medulla, and labor has begun.

The Phenomena of Normal Labor.

The physiology of the processes concerned in the expulsion of the fetus includes a study of the action of the uterine walls, the uterine ligaments, the abdominal muscles, and the vagina; the changes induced by labor in the cervix, in the lower uterine segment, and in the body of the uterus; the variations in the presenting pouch of membranes; and the character of the liquor amnii, the formation of the caput succedaneum, and the changes in the pelvic floor. Then the clinical character of the three stages of labor will be considered, leaving questions of mechanism and management for later sections.

Uterine Contractions.—The uterine contractions of labor go by the name of "pains" in all languages, including the speech of the scientist, because of the suffering inseparably associated with them. The *cause of this suffering* is the compression of the uterine nerves between the contracting muscular fibres, the tension of the external os and lower uterine segment, the stretching of the uterine ligaments, and the pressure of the advancing fetus on the nerves of the vagina, the vulva, and the neighboring structures. Moreover, hyperemia of the lower end of the cord and its envelopes is probably in part responsible for the distress.

The location of the pain is, at first, in the lumbo-sacral region, and later in the abdomen or down the thighs. The most severe degree of pain is felt at the vulva as the head passes. The onset of the contraction is more rapid than the decline. The pain begins suddenly a few seconds after the beginning of the contraction—as may be seen by the bulging forward of the fundus or be felt by the examining hand—reaches and retains for a few seconds its acme of intensity, and then gradually subsides. If each pain be divided into periods of increase, acme, and decrease, the acme will occupy the greatest length of time of the three divisions, the total duration of a pain being about one minute. The suffering is commonly more severe in very young or in elderly primiparæ than in those in the prime of physical life. Susceptibility to pain, and general vigor, have much to do with the amount of anguish experienced, it being among serene women and dull-witted and sturdy-limbed hospital patients that we oftenest see quiet labors. Painless deliveries have been reported, but they are rare.

The muscular fibre of the uterus is non-striated, and the contractions, as in all organs of like histological structure, are *peristaltic, involuntary, and intermittent.* Contractions sweep over the uterus in a peristaltic wave, probably travelling from the opening of the Fallopian tubes down to the cervix, reaching a swift acme, and subsiding within twenty or thirty seconds. Waves in both directions have been observed in the uteri of some of the lower animals. Though mainly controlled by the sympathetic system of nerves, and hence independent of the will, the pains are nevertheless influenced to some extent by the brain—a fact demonstrated by the effect of fright or of excitement in retarding or even in stopping labor. The pains last from thirty to ninety seconds, and the peristaltic action from twenty to thirty seconds; the interval is about thirty minutes at first, whereas at the end of labor it is but two to three minutes, and nearly disappears as the head emerges. Symmetrical pains often occur in groups, followed by shorter or almost abortive pains. As to the *force exerted*, the pressure during the height of a pain never exceeds 100 millimeters (4 inches) of mercury, the average being 60 millimeters (2⅜ inches; Schatz). Leaman measured the force with which the head advanced (not the force with which it was propelled), and found a high pressure to be five pounds. Forceps was required where it did not exceed two and a half pounds.[6] The force of the pain remains about the same during the entire labor, or it may increase by a fourth, and this with no regard to weariness on the part of the patient. The force does not increase with the resistance offered, but the pains simply become more frequent and last longer. The type of the pains is nearly constant in the same patient (Schatz).

The amount of force exerted by the pains is supposed to range between seventeen and eighty pounds. Our methods of measuring, however, are defective. Duncan and Poppel, who studied the force required to rupture the membranes, found that in easy cases it was hardly more than the weight of the child, and only in severe cases did it rise to fifty pounds. Schatz[7] passed a rubber bag into the uterus during labor and connected it with a gauge, registering fifty-five pounds as the maximum. An obstetrician knows that all the muscular power he possesses is sometimes insufficient to prevent rapid expulsion of the head.

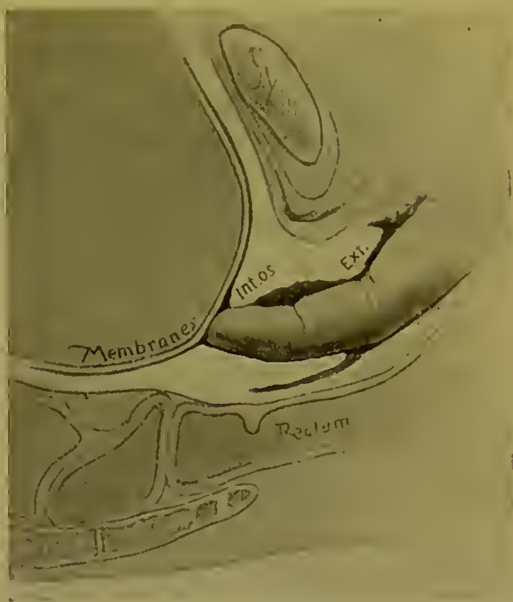

FIG. 166.—Palpation of the cervix before labor. The two rings are shown, with the finger-tip touching what may be called clinically the "internal os" (one-half natural size).

The changes in shape in the uterus during contraction are marked. In the quiescent state it rests against the spinal column, ovoid in shape, the transverse exceeding the antero-posterior diameter. During contraction these diameters become about equal, the uterus assumes an ovoid or somewhat cylindrical form, and by means of this increase of the antero-posterior diameter and the contractile action of the broad and round ligaments the fundus is forced forward against the abdominal wall. At the same time the uterus becomes longer at the expense of the lower uterine segment and the cervix (Fig. 236, p. 425).

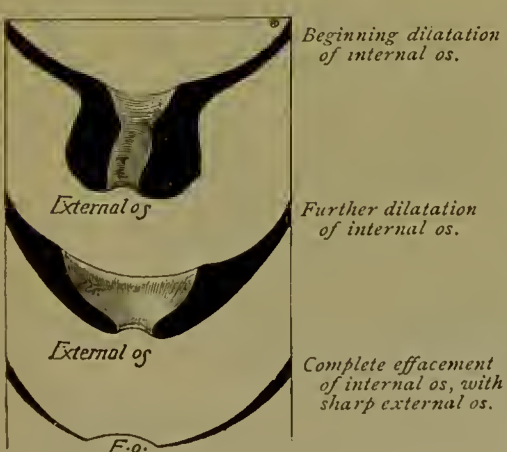

FIG. 167.—Diagram showing the sensation to the examining finger of widening and effacement of the internal os during dilatation of the cervix, and the knife-like edge of the external os (one-half natural size).

Action of the Ligaments.—The uterine ligaments—the round ligaments, the lower part of the broad ligaments, and the utero-sacral bands — contain much muscular tissue which is directly continuous with that of the uterine wall. Contraction of this muscular tissue occurs with each pain, and serves to fix or to steady the uterus in position at the brim, and to assist in lifting and holding it at an angle favorable for expulsion of the fetus (Fig. 211, p. 388).

Action of the Abdominal Muscles.—Next to the uterine contractions the force of the abdominal muscles is the important expulsive agent. We include all those muscles that fix the thorax and pelvis or narrow the abdominal cavity. The resultant of the forces of these muscles lies parallel with the axis of the superior strait (Winckel; see Fig. 211, p. 388). The action on the part of the woman is voluntary at first, but becomes less so as labor advances, as shown by her inability to withhold strong pressure at the time when the pelvic floor is endangered. Such assistance to the uterus is not absolutely necessary, for labor may be accomplished in the absence of the action of these external forces, as in paralysis; but when the head lies in the pocket formed by the curve of the sacrum and the partly stretched pelvic floor, having to turn nearly a right angle in its course, the power brought to bear by the abdominal muscles is of very great moment. From the atrophy of the trunk-muscles due to corset-wearing, failure of force at this crisis often calls for forceps extraction.

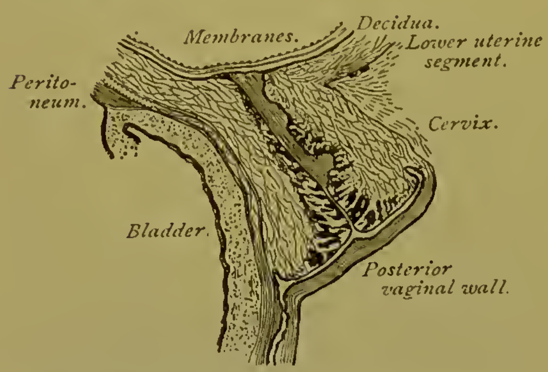

FIG. 168.—Section of cervix at term (Waldeyer). The irregular blotted black marks within the cervical canal, running to the membranes, denote mucous membrane of cervix; the decidua runs in a wavy line beneath the membranes.

The uterus is raised by the round ligaments so that abdominal pressure acts to better advantage. The uterus is compressed from all sides, is supported by the pelvic walls, and is arrested in attempts to slip downward by the utero-sacral and broad ligaments and the sacral curve, while its contents are pressed out. The increased tension on all the contents of the trunk sends blood to the extremities and flushes the face of the patient. Below the pelvic brim the pressure is not brought to bear, and congestion produces edema and softening of the cervix and pelvic floor. At times the child is expelled with considerable force by means of this added power, and the uterus may even be inverted by these efforts of the external muscular structures.

FIG. 169.—Cervix of multipara at beginning of labor; the internal os is at the edge of the crater (frozen section, Winter).

Action of the Vagina.—At first the vagina opposes some obstacle to the advancing head. When, however, a large circumference has passed, any onward motion may receive slight aid from contractions of the vagina. Figure 185 (p. 336) shows how the vaginal walls are smoothly fitted to the child even after the exit of the head has greatly distended the passage.

Changes in the Cervix during Labor.—Although palpation of the external surface of the cervix may give the impression of a smooth expanse of stretched rubber around the opening, yet when the finger is passed within the cervical canal as far as the membranes, is hooked forward, and then slowly withdrawn, one detects two well-defined rings with a 1- to 2-inch (3.5- to 5-centimeter) passage between them, and finds that this passage has yielding side walls (Figs. 166, 167, 174). Whether this inner ring be the true internal os, or only the upper limit of the vaginal portion of the cervix, we may be allowed to call it, for clinical purposes, the internal os, since we need to watch its behavior during the dilatation stage.

At the beginning of labor in the primipara the cervix is barely passable by the finger-tip. Dilatation of the internal os occurs first, and it may open rather widely before the external os begins to gape (Fig. 167). In this case the cervix thins out to a flat ring over the watch-glass membranes, and the external os may form a sharp, parchment-like edge as the internal os merges with the lower uterine segment and the membranes or the presenting part is applied directly to the external os. At other times the two rings draw back in less marked succession (Figs. 169, 170). In multipara the more open canal freely admits the finger during the last month, and the condition is suggestive of labor begun. But an inner edge may usually be distinguished (Fig. 170) until the early labor-pains[8] or the threatening preliminary pains begin. The effect of such early pains in commencing the dilatation of the cervix in certain cases is shown in Figure 175. In multiparæ labor is likely to pull back the whole cervix bodily, but with some thinning and with a somewhat irregular edge. Gradually the circle widens until it merges imperceptibly into the uterine wall, leaving, as a rule, to represent the external os, a slightly raised encircling ring in the wall of the curved birth-tube 3 millimeters ($\frac{1}{8}$ inch) in thickness, located against the back of the symphysis in front and halfway up the sacrum behind (Fig. 134). The wall of the cervix is then 2 millimeters ($\frac{3}{32}$ inch) in thickness, and the cervix is said to be effaced. The anterior lip may be nipped between the bony ring (pelvis) and the ball of bone (fetal head) and become elongated

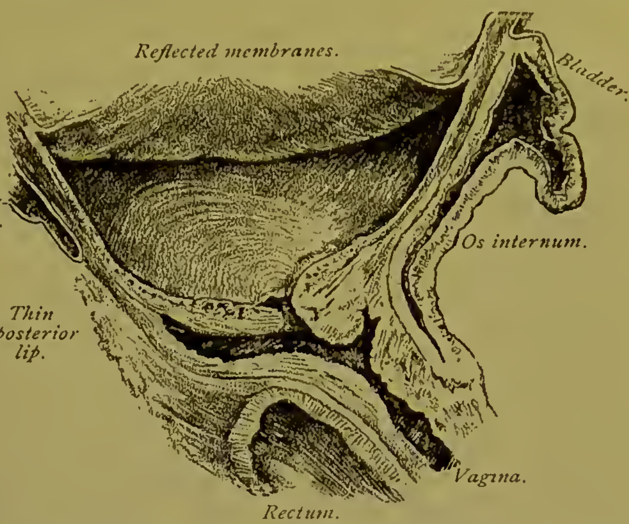

Fig. 170.—Cervix of five and a half months' primipara in dilatation period, with marked irregularity in progress of dilatation of posterior and anterior lips, the posterior being nearly flattened (Winter; frozen section, five-eighths natural size). Compare widening funnel or crater with Figure 169.

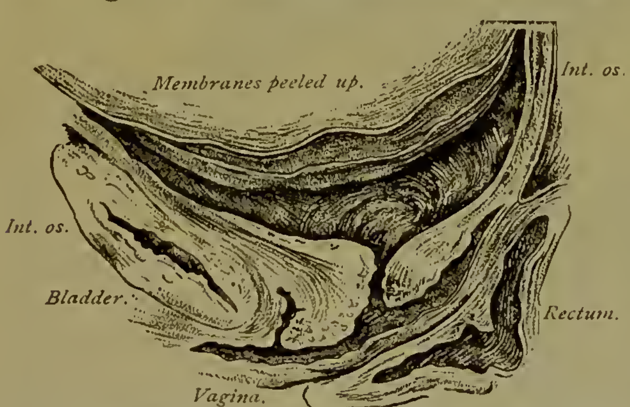

Fig. 171.—Dilating cervix of eight months' primipara, with pronounced thinning of posterior lip (Winter; frozen section, two-thirds natural size).

and edematous, even to the extent of appearing at the vulva during delivery or of hanging without it afterward. In patients with contracted inlets the external os often remains at or near the brim after full dilatation.

The dilatation is estimated either by guessing the coin it seems to resemble in size, or by stating the inches of its diameter, or the number of fingers which the elastic ring will admit. The cervix may not be found greatly dilated, and yet may be dilatable to a large size, as determined by the introduction of four fingers or the whole hand. The common error of the beginner is to

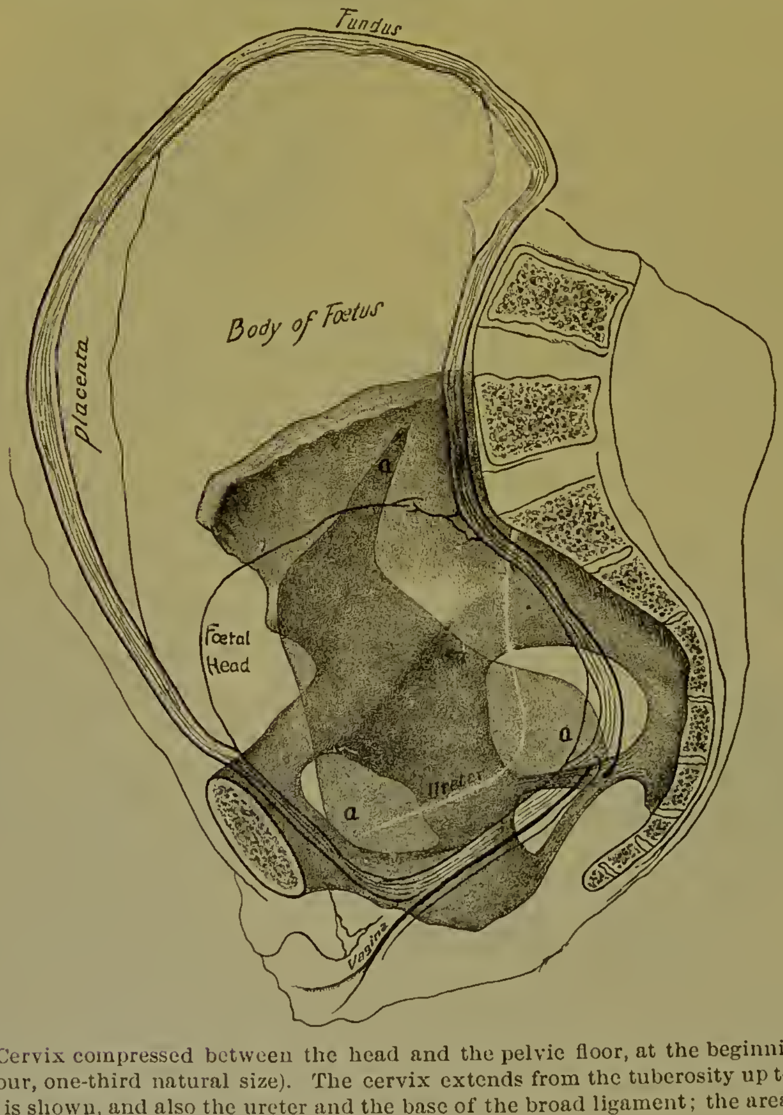

FIG. 172.—Cervix compressed between the head and the pelvic floor, at the beginning of labor in a VI-para (Barbour, one-third natural size). The cervix extends from the tuberosity up to the right-hand *a*; the vagina is shown, and also the ureter and the base of the broad ligament; the area on the side not covered with peritoneum being the shaded space (*a*, *a*, *a*).

believe that the cervix is much more widely opened than it is in fact. He is sometimes deceived into thinking the cervix has gone by the exceeding thinness of the tissue stretched taut over the head (Figs. 167, 210; p. 385), or, again, by the softness of the yielding edges. The cervix may remain in a stationary and partly dilated condition for hours, or, in rare cases, for days. It may close after partial dilatation—even from the size of three fingers.

The *mechanical* factors effecting dilatation are discussed on pages 424–430. The *active* agents are: (1) Contraction of the longitudinal fibres of the uterine body, pulling the cervix up over the ovum; (2) hydrostatic pressure of the bag of waters; (3) wedge-action of the presenting part; (4) softening of the cervix.

There is tension on all the other uterine vessels during a contraction, but the unsupported cervical vessels below the pelvic brim become engorged and the lymphatic interspaces are infiltrated with serum and loosened; thereby the force of cohesion is lessened. Were it not so, the elastic cervix would close down on the shoulders after the passage of the head. "Indeed, the conditions of an elastic tube are not infrequently realized in versions where an attempt is made to extract the fetus through an imperfectly dilated os; in which case, after the disengagement of the shoulders, the cervix is apt to close upon the neck and arrest the delivery of the after-coming head. That this complication does not happen as a rule is due to the fact that in natural labors the mechanical expansion is associated with certain organic changes which render the cervix soft and distensible, and which at the same time diminish its retractility."[9]

To bring the cervix to a circle of a diameter of 5 centimeters (2 inches) frequently demands two-thirds of the total time required for full dilatation. Irregular dilatation is not infrequent, wherein the posterior lip is further effaced than the anterior, or inversely, but the former is more common. From the frozen sections, the first process would seem to be constant in occurrence and most marked in character (Fig. 170).

Location of the Orifice.—The internal os is found at the beginning of labor and in frozen sections 6.3 centimeters ($2\frac{1}{2}$ inches) below the brim, being a little lower than in the nullipara.[10] The cervix may be high and pointing backward, and, in practice, when there is much difficulty in reaching it far up toward the promontory, one may be obliged to hook the anterior lip downward with the finger in successive sections until the external os can be caught (Fig. 356, page 556). A cervix at a long distance from the vulva suggests false labor-pains taking place at an early period of pregnancy, before the occurrence of "sinking" of the uterus, or a contracted pelvis. The cervix may be found low in the pelvis, near the vulva, with the head packed into it, pressing it downward against the pelvic floor and toward the vulvar opening (Fig. 172).

Changes in the Lower Uterine Segment.—The two beliefs concerning this portion of the uterus can only be summarized. Schroeder and his school teach that the lower uterine segment is that part of the wall of the body of the uterus (Fig. 173) extending from the *contraction-ring* above—the level at which the peritoneum is found firmly adherent—to the internal os below; that it is constituted of more loosely adherent muscular layers than the wall higher up; and that it is relatively passive during labor. By its anatomical structure and by the epithelial covering of its mucous membrane the lower uterine segment is differentiated from the cervix in both the pregnant and the puerperal uterus. In pregnancy the internal os may be found by its forming the upper end of the closed cervical canal. With this point the denser structure, with its connective-tissue appearance, the character of mucous membrane and its junction with the decidua above, and the upper limit of the arbor vitæ, usually coincide. The lower segment differs distinctly from the upper, to which it belongs anatomically, in possessing loosely connected muscular layers which are easily separated, whereas the rest of the body of the uterus is made up of inseparably interlaced bundles which can only be dissected from one another, even in the thinnest layers, by destroying the structure (Hofmeier).[11] "The physiological behavior of the lower uterine segment during labor is essentially passive, as opposed to the remaining portion of the uterus, which is sharply contrasted with it by contractions." The difference between the two is palpable, after vigorous uterine contractions, to the hand within the cavity, the ring being occasionally detected by the hand without as well. The term "contraction-ring," though firmly seated, should yield, in the writer's opinion, to the more correct "retraction-ring," which is self-explanatory.

The writer has given precedence to the views of those investigators who believe that the cervix remains unchanged until the beginning of labor. Only

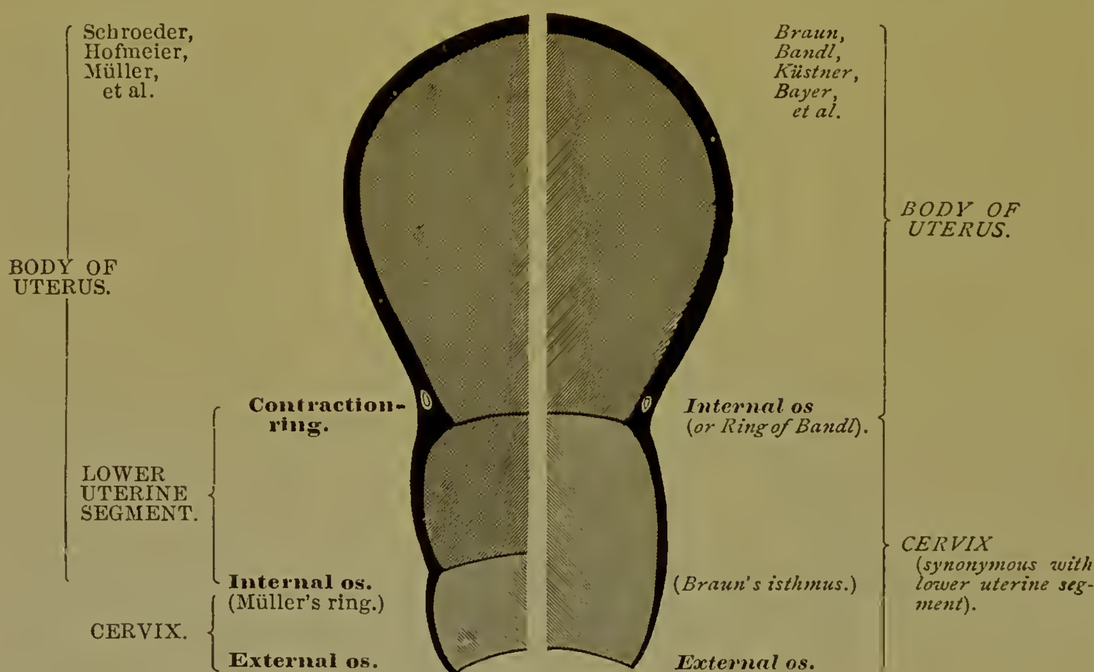

FIG. 173.—Diagram illustrating the two teachings anent the lower uterine segment and the cervix. On the left side an internal os has been added for the sake of clearness, although in the frozen sections of women with full dilatation it is rarely apparent macroscopically (one-third natural size).

the briefest outline, however, of the voluminous controversy[12] can be given, and the opposite side stated. The older theory held that toward the end of pregnancy the upper portion of the cervix was expanded and drawn up to form part of the general uterine cavity, leaving only the small vaginal portion of the cervix below. Braun, whose section is given in Figure 134, believes that the semicircular ledge with the large vein (*Kranzvene*) is the internal os, 10 to 11 centimeters (4 inches) above the external os; Bandl confirms this. He now believes,[13] with Küstner, that in first labors the mucous membrane of the dilated portion of the cervix—the lower uterine segment—becomes torn or stripped off, and subsequently there is formed upon the denuded surface a new membrane not distinguishable from that of the corpus, which in future pregnancies is capable of forming a decidua. Bayer[14] concludes that "the excessively thin decidua of the lower uterine segment passes into cervical mucous membrane on the posterior wall of that segment, and that the lower uterine segment and supravaginal cervix are one and the same thing. It envelops the presenting part during labor, it is thinned out, distended, paralyzed, while the thick, contractile muscle-mass of the corpus lies above, where the phenomena of contraction occur with their expulsive effect upon the uterine contents."

Practically, the lower uterine segment interests us as the common seat of rupture of the uterus. During long labors, or where obstruction is associated with vigorous contractions, extreme thinning occurs at this level, and in such cases the retraction-ring can sometimes be felt as a band or ridge in the vicinity of the navel to serve as a danger-signal.

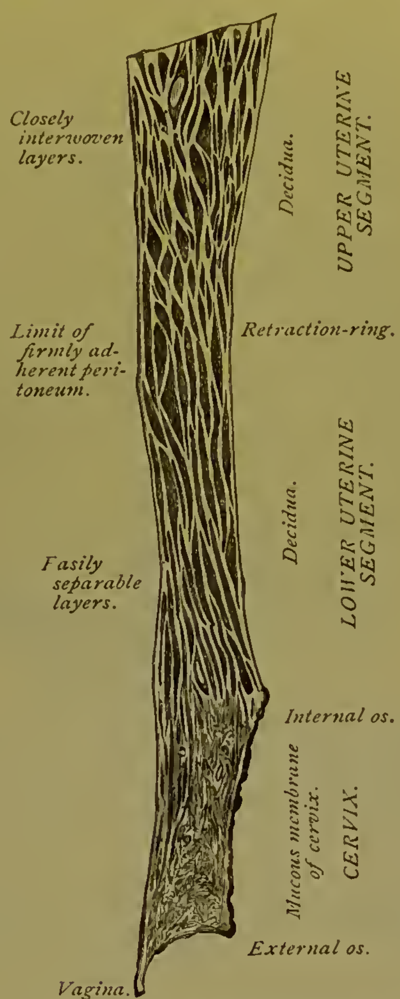

FIG. 174.—Section of the wall of the pregnant uterus (Hofmeier). The difference in texture between cervix and lower uterine segment, according to Hofmeier, is clearly shown, as well as the loose-meshed and close-meshed muscle-layers of the upper and lower uterine segments.

The thickness of the lower uterine segment was measured by the writer on such of the frozen sections as would admit of study. In 5 cases at the eighth and ninth months of pregnancy the average thickness of the wall was 6 millimeters ($\frac{1}{4}$ inch), the extremes being 5 and 10 millimeters ($\frac{3}{16}$ to $\frac{6}{16}$ inch). In 5 cases in the stage of dilatation the average thickness was 3.6 millimeters ($\frac{1}{8}$ inch), the extremes being 2 and 5 millimeters ($\frac{1}{16}$ to $\frac{3}{16}$ inch). In 6 cases in the expulsion stage the average thickness was 3.5 millimeters ($\frac{1}{8}$ inch), the extremes being 2 and 7 millimeters ($\frac{1}{16}$ and $\frac{4}{16}$ inch plus). The remarkable thing in this series is that there are so many instances where a measurement close to 2 milimeters ($\frac{1}{16}$ inch) was found, in some sections of the wall, either in the first or the second stage—namely, in seven different patients. Thus we may say that *before labor the wall of the lower uterine segment is 6 millimeters* ($\frac{1}{4}$ inch) *thick*, and *during labor 3.5 millimeters* ($\frac{1}{8}$ inch). Anterior and posterior walls are rarely equal in thickness, but the sections are nearly equally divided on thinner anterior or thinner posterior walls.

Changes in the Body of the Uterus.—Thickening of the wall of the upper uterine segment is a somewhat constant factor. It is especially marked in long or obstructed labors (Figs. 134, 185, 288). The average thickness of the uterine wall at term is the same as during the early dilatation stage, as measured on eight frozen sections—namely, 7 millimeters ($\frac{1}{4}$ inch). Toward the close of the expulsion stage it is, on five sections, from 9 to 18 millimeters ($\frac{1}{4}$ to $\frac{3}{4}$ inch), averaging 1 centimeter ($\frac{3}{8}$ inch).

FIG. 175.—Section of primipara of twenty-ninth week, showing beginning dilatation of the cervix in the absence of painful contractions: *mp*, mucous plug; *io*, internal os, with attachment of membranes (Ahlfeld; hardened preparation, one-third natural size).

Bag of Waters — Fore-waters.—Through the dilating cervix the fetal envelopes are felt, growing tense during the pains or just before the sensation of suffering comes. The ovum is being peeled off the lower uterine segment and protruded. We note the amount of tension, the shape of the protruding sac, and its volume, and, later, the location of the tear. The tension is usually intermittent, as above stated. At times we detect a permanent lesion and look out for hydramnion or twins.

The shape of the sac depends on the shape or size of the presenting part, the elasticity of the membranes, and the amount of liquor amnii. It may be (1) Flat; (2) watch-glass—this is usual with vertex presentations (Fig. 176); (3) hemispherical—it may bulge full and round (Fig. 177); (4) glove-finger—it may be elongated

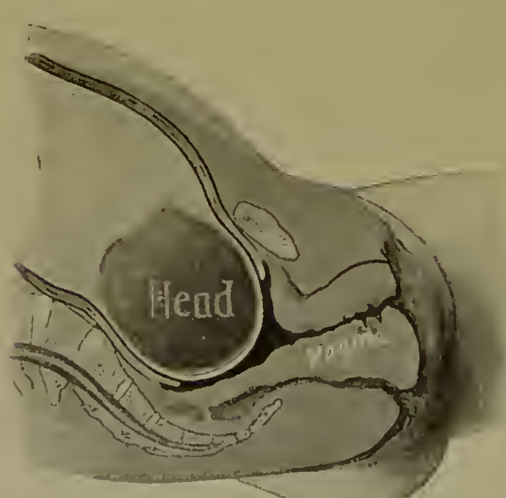

FIG. 176.—Form of membranes during dilatation, watch-glass (Varnier): the presenting part is large and fills the cervix (one-sixth natural size).

FIG. 177.—Form of membranes with less efficient filling of cervix and pelvis, and larger quantity of fore-waters (modified from Varnier).

in shape when the cervix is narrow and the presenting part does not fill it, as in knee or shoulder presentations (Fig. 178); (5) pear-shaped (Fig. 179), as where the fetus is dead and macerated;[15] (6) double, as with twins—but very rarely.

The membranes are slightly permeable under pressure (Tarnier and Pinard), and at times the amnion will leak into the chorion, giving a double pouch. Some of the vaginal flow has been credited to this source.

The cervix and lower uterine segment are drawn up over the protruded ovum. The chorion often separates from the decidua. The attachment of

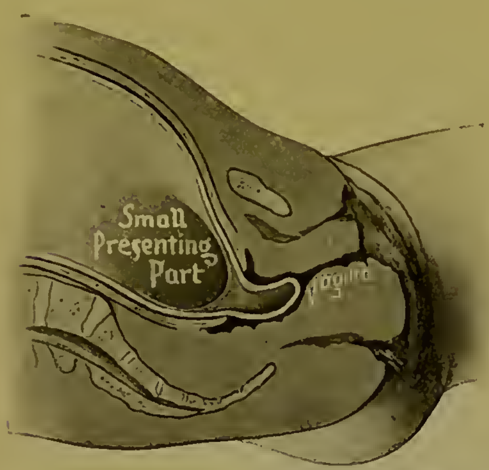

FIG. 178.—Glove-finger form where the presenting part is small (modified from Varnier).

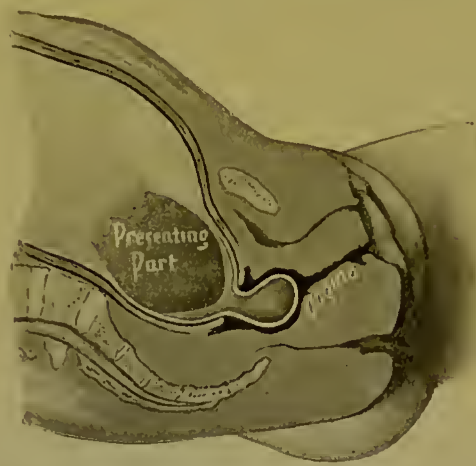

FIG. 179.—Pear-shaped pouch seen with some cases of macerated fetus (modified from Varnier).

the membranes until the beginning of labor is at the internal os, or upper limit of the apparent cervix. In normal cases[16] the coverings of fetal origin are not separated, maternal and fetal membranes parting at the level of the lower pole. In certain cases before rupture the chorion and amnion may already be separated throughout or far up on the cord.

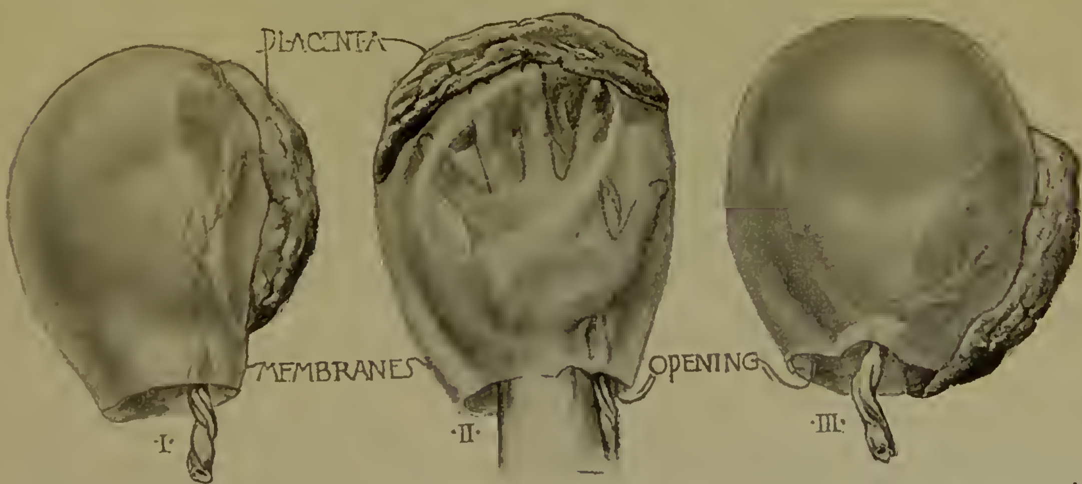

FIG. 180.—Placenta and membranes after delivery, to show how the relation of the opening to the placenta indicates the site of the latter: I., lateral implantation; II., fundal implantation; III., placenta prævia marginalis.

Normally the membranes give way on full dilatation of the cervix when pressing on the pelvic floor. At times rupture occurs days or hours before labor, from low implantation of the placenta.[17] In Poullet's case the membranes gave way six days, and in that of Matthews Duncan forty-five days, before labor. A copious discharge of fluid that has collected between the ovum and the uterus and due to a catarrhal endometritis, called "hydrorrhœa gravidarum," may deceive one into believing that the amniotic sac is empty. A more common cause of error is the gushing of odorless hysterical urine. At times rupture is delayed until the membranes bulge through the vulva. In rare instances the child is born enveloped completely in the unbroken sac; this is the "caul."

The chorion usually gives way first, having a firmer attachment, as the amnion can loosen over most of its surface and slip downward and out. The seat of rupture may not correspond with the opening of the cervix. If it is on the side wall, the waters may leak more slowly, but this slow flow of the fore-waters is not very often seen, although discharge of the hind-waters in jets, as the presenting part recedes from its tight fit in the cervix during a contraction, may simulate it. Frequent gushes of so-called "liquor amnii" are often only urine. After rupture the waters may come away with a forcible gush or may leak slowly. On examination after delivery the position of

FIG. 181.—Location of the caput succedaneum, and its indication of the original position of a vertex presentation.

the tear in the membranes shows the location of the placenta in the uterus (Fig. 180). An opening opposite the after-birth would denote implantation in the fundus; a tear close to the margin of the placenta would indicate placenta prævia; and one of the intermediate degrees is also shown.

Character of the Liquor Amnii.—Ordinarily the waters have a slightly turbid, yellowish color. At times the amniotic fluid is thick with greenish or brownish meconium, due, perhaps, to undue pressure on the child, and sometimes indicative of danger, except in breech presentations. Flakes of skin and a muddy consistency suggest a macerated fetus. Bright blood in any quantity within the membranes indicates premature separation of the placenta with leakage into the amniotic sac, but is very rare.

Formation of the Caput Succedaneum.—The caput succedaneum is an edematous swelling that develops on the presenting part of the child as the cervix expands. The cervix makes pressure all over the presenting part during uterine contractions, except at one spot, and here serous infiltration develops a doughy prominence. The size of this swelling varies with the duration of the labor. If it occurs on the face, the grotesque disfigurement alarms the family, but the swelling subsides in a day. The scrotum may assume large dimensions in breech labors. On the scalp the position of the edema serves to indicate the position in which the head enters the pelvis, provided too long delay in the lower birth-canal has not occurred. The tumor is located on that end of the head and that side of the head opposite in name to the position. Thus in the left occipito-anterior position it is found to the right posteriorly; in right occipito-posterior, to the left and front (Fig. 181).

Clinical Course of Labor.

Signs of Beginning Labor.—From eight to fourteen days before labor "sinking" or "lightening" occurs in a considerable number of patients. The uterus drops lower, the fundus falls forward, the head engages or descends to lie on the pelvic floor (Fig. 172), and as a consequence the patient experiences a sense of relief, breathes more freely, digests better, and has looser waistbands. This may never occur in a given patient, or it may happen two days or four weeks before delivery. In half the primigravidæ Brühl examined he found the greatest circumference of the head beneath the brim at the end of pregnancy where the inlet was roomy, whereas in only one-third of the multigravidæ was this condition seen, owing to the laxer state of the abdominal wall after first pregnancies. On the other hand, irritability of the bladder and venous obstruction in the legs or the labia, with more difficulty in walking, may result from the intrapelvic pressure. At the time of subsidence the intermittent contractions may begin to be painful, so that labor is supposed to be under way, the pains often being grouped in certain parts of the day or night, and being most commonly seen among multiparæ. Late in pregnancy the vagina and the vulva are relaxed, a glairy mucus lubricating them and facilitating internal pelvic measurement and examination.

The only certain method of determining whether labor is under way is by digital exploration of the cervix. By passing the finger within the cervix and hooking it forward we may determine whether the internal os is widening or disappearing (Fig. 166), and the whole tubular canal of the cervix is being thinned and drawn up; for we must remember that in over-distention of the uterus, as in cases of hydramnion or twins, or in the relaxed state of some multiparous uteri, or where there has been wide laceration, the cervix gapes in the last month, and that a low position of the fetus flattens the cervix between the head and the pelvic floor (Fig. 172).

We are warned that labor is actually under way by the following signs:

1. Irritability of the bladder and the rectum becoming more marked than before, micturition being particularly affected.

2. The "show"—an escape of blood-streaked mucus, due to slight lacerations of the cervix. This sign is not constant.

3. Expulsion of the mucus plug from the cervix—a sign not often detected.

4. Increased secretion. Both cervical and vaginal mucus is poured out in such a manner that when the passages seem soaked and softened with free mucilaginous discharge we may expect to find cervical dilatation making good progress.

5. Rhythmical uterine pains. The most conclusive symptom of beginning labor is the occurrence of regularly recurring pains, with lessening intervals and increasing force, and the most conclusive sign is that stated above—namely, beginning dilatation of the cervix.

Stages of Labor.—The *first* stage, better called the *dilatation* stage, ends with the complete canalization of the utero-cervical zone. The *second* stage,

FIG. 182.—Pelvic floor before distention (modified from a frozen section by Braun and Zweifel, one-third natural size): the edema and thickening seem excessive, but Webster's measurements show that this floor is rather thinner than the average.

the *stage of expulsion*, ends with the birth of the child. The *third* or *placental stage* ends with complete evacuation and lasting retraction of the uterus.[18]

The First Stage, or the Dilatation Stage.—When labor is fairly started the contractions of the uterus assume a certain regularity, characterized by decreasing intervals and by increasing force and painfulness. Occurring at first about every half-hour and only slightly discomforting, with some sense of pressure, the contractions gradually run closer together until, toward the end of dilatation, they give but momentary intervals of relief. The pain is located as a rule in the sacral region, and later extends to the lower abdomen or down the thighs. The patient is restless, standing, sitting, moving, tossing, wringing her hands, seizing on a support, calling for pressure against the sacrum, or begging for relief. Her outcry is involuntary, high-pitched, or apologetic, an impatient protest, or a plaint. She can be persuaded with difficulty that any progress is being made by such colic, seemingly futile. Her cries are not like those of the second stage, which is marked by a transition to the groan or grunt of effort as she closes the glottis and strives to expel the child. The maternal pulse increases in frequency during a uterine contraction, while the fetal pulse is

FIG. 183.—Fully-distended pelvic floor (over one-third life size).

retarded at the acme of the pain. The temperature in normal labor rarely rises 1° F. Urine is freely secreted during this stage, and attacks of shivering or vomiting may occur toward its end. With each pain the cervix grows tense, the border becoming sharp and the membranes protruding, to retreat again as the edges relax. Gradually yielding and softening, with abundant mucus-secretion, the retreating edges permit the membranes to rest broadly on the pelvic floor. When the opening measures 7.6 centimeters (3 inches) the bag of waters usually gives way and the "fore-waters" escape, clear or milky, with particles of vernix caseosum, while the bulk of the amniotic fluid is held back by the ball-valve action of the head. After a pause pains recur and the head descends, and the rim of the cervix is pushed back against the pelvic walls until its edges are hardly perceptible, the cervix being flattened against and practically continuous with the vaginal walls.

The duration of the stage of dilatation varies from two hours to several days. In the primipara twenty-four hours is not uncommon, and the length increases with the patient's age, averaging over thirty hours at forty years (Deeterlin). To give a figure for the student to remember, we say that the average duration in the primipara is fifteen hours, in the multipara eight hours.

The Second Stage, or the Stage of Expulsion.—We are not here concerned with the mechanism, which will be treated later (p. 430). The patient has a fully-dilated cervix, ruptured membranes, and a fetal head resting on the pelvic floor. The character of the pain changes; it is no longer teasing

FIG. 184.—Diagram of the pelvic floor before and during the process of thinning or stretching. It will be seen that the structure is thinned rather than driven forward (one-third natural size).

and inefficient; the impulse to drive out the great mass that presses toward the outlet brings about an effort by the diaphragm and abdominal muscles with closed glottis; steadying herself or pulling hard on sheet or assistant, she strains to bring all her strength to bear; instinctively, as in the savage races, she takes the semi-recumbent posture that brings the uterus upright; and her outcry is the groan of great effort or the moan of ended exertion. With each pain the pelvic floor bulges and then recedes; the vulva gapes and the head appears; the parts behind the outlet grow thinner and more dangerously tense; the acme of suffering has arrived. As the head protrudes through the opening the pains grow stormy, and, reckless of injury, the mother drives out the torturing obstruction. The fourchette slips back over the face and is snugly applied to the neck or shoulder (Fig. 185). Now occurs a pause of from one to five minutes. The child may grow dusky, or may attempt to breathe, thus drawing into the air-passages fluids taken into the mouth.

Usually the next pain expels the trunk, which is followed by a gush of liquor amnii, with some blood. *The duration of the expulsion stage* varies from ten minutes to six hours. In primiparæ the average is two hours, in multiparæ one hour.

Changes in the Pelvic Floor.—The pelvic floor is the fleshy diaphragm dovetailed into the bony outlet of the pelvis. It is about 5 centimeters (2 inches)

Fig. 185.—Pelvic floor after the escape of the head (one-third natural size): constructed from the Zweifel frozen section to show the pushing forward of the anterior vulvar commissure also, and the remarkable way in which the child is packed into the birth-canal. The passage of this head through the pelvic cavity might well result in rupture of the uterus.

in thickness, concave above and covered with peritoneum, and convex in shape on its lower skin-surface. Between these surfaces lie fasciæ, muscles, connective tissue, and fat, named in the order of their physiological importance. Through the floor run three slits, the urethra, the vagina, and the rectum-anus. The axes of these openings are oblique (Fig. 184), so that direct pressure from above tends to close the openings by pressing their walls together. Ordinarily their capacity for distention is limited, but the remarkable character of the pelvic floor is that, whereas the chief function of this unique structure is to form a solid and unbroken support for the organs above it under all conditions of strain, at certain moments it must, without injury, efface itself, and open up to the size of its entire length and breadth. We shall consider the changes that bring about this result.

Hart, studying frozen sections mainly,[19] observed that the vaginal slit divides the structure into an anterior part, which he named the *pubic segment*, triangular in shape, composed of retropubic fat, bladder, urethra, and anterior vaginal wall, attached (loosely) to the pubes; and a much larger and stronger postèrior part, the *sacral segment*, between the rear vaginal wall and the posterior bony wall, including the anus and part of the rectum. Symington[20] considers that the rectum and bladder and the upper vagina, like the uterus, should not be regarded as parts of the floor, but as organs resting upon it. Webster[21] holds that the bladder is imbedded in the pelvic floor, and that the vagina and cervix are parts of it, together with the rectum from the coccyx down. In the illustration (Fig. 186), for obvious reasons, the bladder and cervix have been omitted.

Late in pregnancy the changes that belong to the pelvic floor are relaxation from edema, moderate increase in thickness, and a low droop or "bulging

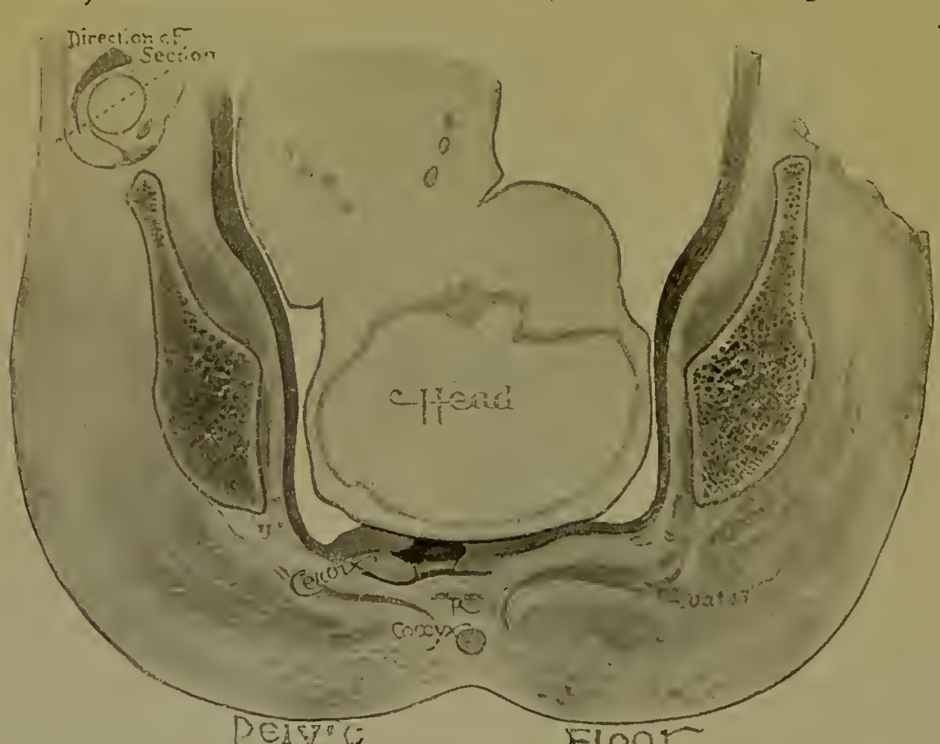

FIG. 186.—Pelvic floor seen in axial coronal section (modified from Hart).

downward." All these changes favor the stretching that is to come. The maintenance of its former axis by the vagina, its distance from the symphysis, the shape of the pelvic floor at this time, and the low position before it is opened up into an oblique hernial canal are shown in Figures 182, 184, and 186.

During labor, in the dilatation stage the parts anterior to the vagina are restrained from being driven down by the upward traction of the longitudinal fibres of the uterus on the anterior lip of the cervix, to which the bladder is attached. As the os is drawn up the bladder and urethra are somewhat elevated, the former coming to lie at the back and partly above the pubes, flatly compressed against the bone, together with the urethra, by the descending head. The utero-vesical pouch of peritoneum is stripped upward from the bladder (Webster), and the urethra is not elongated.

The parts posterior to the vagina, composing the sacral segment, are of more clinical interest. The change in position here is rather a pushing backward than a driving downward, and is accompanied with excessive thinning. The centre of the perineal skin-surface, and with it the important tendinous centre of the perineum, is only driven down in the long axis of the body 2.5 centimeters (1 inch), while the 5-centimeter (2-inch) perineal pyramid is attenuated to 4 or even to 2 millimeters ($\frac{4}{32}$ or $\frac{2}{32}$ inch).* The sacral segment is moderately elongated. From the tip of the sacrum to the posterior commissure before labor is about 16.6 centimeters ($6\frac{1}{2}$ inches). During full stretching by the head the Varnier section measures 19 centimeters ($7\frac{1}{2}$ inches), and the writer's hospital measurements averaged 18 centimeters ($7\frac{1}{4}$ inches). The sphincter ani gapes a little over an inch (Hart), and assumes the form of a D laid on its side (thus, ᗜ), while the anus is displaced backward (Fig. 184, A, A, A).

The figures may be summarized as follows:—

	Centimeters.	Inches.
Thickness of the pelvic floor in front of the anus, in nullipara (Webster)	3.3	$1\frac{1}{4}$
" " " " at term, before stretching	7	$2\frac{3}{4}$
" " " " moderately distended	2.5	1
" " " " fully distended	.3	$\frac{1}{8}$
Projection of pelvic floor, in nullipara	2.5	1
" " " at term, before stretching	7	$2\frac{3}{4}$
" " " at greatest distention	9	$3\frac{3}{4}$
" " " on twelfth day of puerperium	2.5	1
Length of perineal body, from fourchette to anus, in nullipara	3.3	$1\frac{1}{4}$
" " " after complete dilatation by the head	6.5	$2\frac{1}{2}$

The Third Stage of Labor, or the Placental Stage.—The processes whereby the placenta is separated and expelled and retraction of the uterus is secured are given on page 440. Clinically we note that the fundus is hardened by firm uterine contraction, and is located above the brim, but below the level of the navel. Blood trickles in small quantity from the vagina during the pause, the total blood-loss in a labor averaging less than 500 grams (18 ounces). After a rest rhythmic uterine activity is renewed, and the placenta comes away, followed by the membranes, and the corpus is found to have but half the former breadth and to be halfway to the navel. Very moderate stimuli—such as friction, nursing, a douche of hot water—will now produce good contraction, whereas strong excitors may have failed while the uterus was distended.

* The figures used in this discussion are drawn in a certain degree from Webster and Varnier, but are mainly based on an independent study of eighteen frozen sections that range from the eighth month to the middle of the expulsion stage, and are corrected by a number of lead-tape tracings of the pelvic floor during labor.

The average *duration of the placental stage* is from twenty to thirty minutes. The placenta may follow the child at once, or it may remain two hours. After that time the case belongs under the head of Pathology.

Duration of Labor.—The length of labor varies within very wide limits, and our definite statements of averages do not claim accuracy. The exact hour of the onset of labor is often impossible to fix. Labor is usually longer in the primipara than in the pluripara, on account of the greater resistance of the soft parts during the first delivery. It is longer, as a rule, in the very young and in the elderly primipara, and in the stout than in women of slighter build. Spiegelberg's 506 cases are commonly quoted, wherein the three stages in the primipara are averaged respectively at fifteen hours, two hours, and half an hour, with a total of about seventeen hours, while the multipara is listed at eight, one, and one-half, the total being given as eleven hours. Many of the text-books are non-committal. The majority, however, estimate the duration of labor in the multipara at eight hours—not varying greatly from Spiegelberg's figures in other respects.

Table of Average Duration of Stages of Labor in Hours.

	Dilatation Stage.	Expulsion Stage.	Placental Stage.	Total.
Primipara	15	2	½	17
Multipara	8	1	½	9

Spiegelberg[22] states that labor most frequently begins between 10 and 12 o'clock in the evening, and the end of labor occurs twice as often between 9 P. M. and 9 A. M. as in the other twelve hours. West[23] found, in 2019 cases, 40 per cent. delivered between 11 P. M. and 7 A. M., and the most favored time is between midnight and three in the morning. A larger number of rapid labors are said to occur in summer than in winter (107 : 100).

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II. THE CONDUCT OF NORMAL LABOR.

1. Antisepsis.

Nowhere do we find more striking proofs of the value of the antiseptie system than is shown in the diminished puerperal mortality and morbidity in hospitals since the introduction of antisepsis into obstetric practice. Before the advent of Listerism the usual death-rate from childbed fever in lying-in hospitals was from 2 to 10 per cent., and in so-called "epidemics" this limit was often exceeded. In the women who survived, feverless childbeds were comparatively infrequent. Under antiseptic methods the mortality from sepsis in well-managed institutions is less than 1 in 200, and the morbidity does not exceed 10 per cent.

A few examples will suffice to show what is possible under the present perfected system of aseptic obstetrics. Professors Groth, Netzel, and Sonders of Stockholm report[1] 17,862 births under their direction (1880–89), with 1 death in 344, or .29 per cent. In Copenhagen (1888–89), in 1218 hospital deliveries the death-rate was .24 per eent. Slawiansky[2] tabulates the results of 176,646 deliveries in fifty-three hospitals of Russia (1881–89), showing a morbidity of 8.57 and a mortality of .38 per cent. Leopold[3] records 3089 cases (from May, 1885, to May, 1887) without a death from septic infection.

The Boston Lying-in Hospital (1891) recorded 550 deliveries with no death from septic causes. In 1892 there were 515 confinements with but 1 fatal case from septicemia—a mortality of less than 0.1 per cent. for the two years.[4] In the Sloane Maternity, New York City, there has been thus far but 1 septic death in 3000 deliveries.[5] In the New York Maternity Hospital 957 women were delivered during the three years ending Oct. 1, 1893, without a death from sepsis.[6]

While in pre-antiseptic times the puerperal mortality was many times greater in public institutions than in private practice, to-day the pauper delivered in a hospital is exposed to less risk than are the well-to-do classes who are confined in their own homes. Insurance reports show that of all deaths in women between the ages of nineteen and twenty-nine more than 18 per cent., and between twenty-nine and thirty-nine years more than 13 per cent., are due to puerperal causes. From 65 to 75 per cent. of puerperal deaths are attributable to sepsis. It is fair to assume that these statistics have to do almost wholly with a class who are delivered outside of hospitals. This indicates a mortality that is truly appalling, especially when one reflects that it falls upon women in the prime

[1] *Verhandlungen des X. Internationalen Med. Cong.*, B. 111. [2] *Ibid.*

[3] *Deutsche med. Wochenschrift*, vol. xiii. No. 25.

[4] Communication to the writer from Dr. Charles M. Green, Sept., 1893.

[5] Personal letter from Prof. J. W. McLane, Oct., 1893.

[6] Personal communication from Dr. Robert A. Murray, Oct., 1893.

of life and usefulness, and is the result of a preventable disease. Yet the disastrous effects of puerperal infection are not represented by the mortality alone. Thousands of invalid mothers owe their impaired health to the milder grades of sepsis in childbed. No stronger evidence could be offered than is afforded by the foregoing facts of the need for improvement in the obstetric methods of the general practitioner.

Obstetric antisepsis dates from 1847. To Ignatius P. Semmelweis, a young Hungarian who at that time held the position of assistant in the lying-in department of the Vienna General Hospital, belongs the credit of first demonstrating its efficacy. The obstetric service of the hospital was divided into two sections, in one of which instruction was given to midwives, in the other to medical students. It was with the latter that Semmelweis was connected. The students in this department were at the same time actively engaged in the pursuit of practical anatomy and pathology. The women were delivered by students who for a considerable portion of their time were occupied with the operations of the dead-house and the dissecting-room. They took no precautions to cleanse themselves except to wash their hands with soap and water, and they made examinations *ad libitum.* The death-rate was excessive, reaching nearly 10 per cent. of the women delivered.

Horrified at this frightful mortality, Semmelweis bent his energies to finding the cause. He was struck with the fact that in the midwives' clinic the death-rate was little more than 3 in every 100 women confined. The records showed also that women delivered before admission nearly all escaped. It appeared, too, that prolonged labors in the students' clinic were almost invariably followed by death, while in the midwives' section the length of the labor made little difference in the mortality. During the time that Semmelweis was engaged in his investigations Prof. Kolletschka, one of his associates, lost his life by a dissection-wound. The symptoms of his colleague's illness were entirely similar to those of the fatal malady which was raging in his own wards. Impressed with the identity of the two diseases, it dawned upon him that the cause of the deadly scourge was to be found in the infected hands of the students who attended the labors.

In May, 1847, he established the order that students before taking charge of a labor case should wash their hands in chlorin-water or in a solution of chlorinated lime, and he restricted the number of examinations. The result was an immediate fall in the death-rate. In six months it had dropped from nine or ten to three per hundred, and in the second year of the new régime it did not exceed 1.5 per cent. No proof could be clearer of the correctness of his views, yet they were bitterly opposed by the profession. He struggled in vain for the acceptance of his theories. He was ridiculed and despised, and finally died insane, the victim of continued persecution.[1]

Soon after its introduction into surgery by Sir Joseph Lister in 1866 antisepsis began to gain a permanent foothold in obstetrics. First adopted in

[1] For many of these facts the writer is indebted to an address by C. T. Cullingworth, M. D., F. R. C. P., entitled *Puerperal Fever a Preventable Disease.*

1870 by Stadfeldt of Copenhagen, it was taken up by the principal maternities of Europe, and to-day, with many improvements in the technique, it is universally practised in the lying-in hospitals of the world.

Practical Rules for Disinfection.

Instruments, Utensils, and Dressings.—The most efficient of all germicidal agents is heat. For instruments, utensils, sutures, and dressings that will not be injured by high temperatures heat affords the best means of disinfection. Either of three methods, dry heat, boiling, or steaming, may be employed.

Dry Heat.—For metallic instruments and for most utensils exposure in an oven is a convenient and effective method of sterilizing. It is necessary, on the one hand, to make sure that the temperature reaches at least 284° F., and, on the other hand, that it does not exceed 400° F., at which point the temper of steel instruments would begin to suffer impairment. For greater accuracy in regulating the temperature a thermometer specially made for the purpose may be used. As some time will be required to bring the instruments to the necessary degree of heat, the exposure should be maintained for at least fifteen minutes to ensure proper sterilization.

Boiling.—A ready means of sterilizing most instruments is by boiling them ten minutes in water. The addition of 1.5 per cent. of washing soda to the water helps to remove greasy matter and prevents steel instruments from rusting. The soda should, if possible, be chemically pure. This method has the advantage that it is available in any household. All that is needed is a vessel large enough to hold the necessary instruments and appliances and a range fire, gas stove, or even a large alcohol lamp. In emergency no more elaborate apparatus is required than a common dish-pan. Place in it the instruments, silk sutures, sponge compresses, and other materials to be sterilized, cover them with water, and boil for the requisite length of time. Turn off the water, and the pan serves as an aseptic instrument-tray.

Steaming.—Sterilization by steam requires special apparatus. Numerous appliances are to be had for the purpose, one of the most economical of which is the Arnold steam-cooker. This process is available for practically all instruments, dressings, and utensils not too bulky to be contained in the sterilizer. It is well to place the articles to be sterilized in a wire basket or a cloth bag in which they may be lowered into the steam-chamber. This facilitates handling and makes it possible to remove the instruments promptly on opening the sterilizer. If allowed to remain in the steam-chamber for even a few seconds after air is admitted, the instruments become wet with condensed steam and polished steel surfaces are liable to tarnish. The time required for sterilization is from ten minutes to an hour, according to the bulk and character of the materials. Dressings need the longest exposure.

In the labor ward of a hospital a steam-sterilizer may be kept in operation during the labor, and the instruments, compresses, sutures, and dressings may be taken direct from the steam-chamber as they are wanted for use.

Chemical Antiseptics.—Among the chemical agents most commonly employed for obstetric antisepsis are the mercuric chlorid dissolved in water, in strength of from 1 : 2000 to 1 : 500, the mercuric iodid in similar proportion, the peroxid of hydrogen[1] (15-volume solution), the liquor sodæ chlorinatæ diluted with 9 volumes of water, a 2 per cent. creolin mixture (in water), a 2 to 5 per cent. solution of carbolic acid, and a 1 : 1000 solution of hydronaphthol. The order in which they are named is substantially that of their germicidal potency.

The practical efficiency of mercuric chlorid (corrosive sublimate) is greatly increased by the addition to the solution of five parts of hydrochloric, tartaric, or acetic acid for each part of the sublimate, since in neutral solutions of that salt the mercury is precipitated as an albuminate on contact with blood or with other albuminous liquids. The acid, moreover, serves to protect the solution against impairment of strength by contact with the alkaline fluids of the tissues. The mercuric chlorid is decomposed by alkalies. The mercuric iodid (biniodid of mercury), requires the addition of an equal weight of the iodid of potassium to render it freely soluble. With this salt no acid is required. Neutral solutions of the mercuric iodid yield no precipitate with albumin. The chlorinated-soda solution, the peroxid of hydrogen, and the creolin mixture have the advantage of being practically non-poisonous, and they are therefore more suitable to be trusted to the nurse than the mercurial preparations.

The Obstetrician.—The obstetrician should always be clean; especially must his hands be clean, and he should wear clean clothing. It is well to avoid contact with pathological material and, so far as possible, with other sources of wound-infection. Yet attendance on post-mortems and contagious diseases is not necessarily inconsistent with the safe conduct of confinements, provided a rigorous antiseptic cleansing be always observed as a preliminary to the care of the obstetric patient. After a septic exposure an entire change of clothing and repeated and conscientious use of disinfectants must be practised before taking charge of a case. The writer has repeatedly attended a prolonged labor, has delivered by forceps, and has repaired perineal ruptures within one or two hours after having the hands bathed in offensive pus, without infecting the patient. Repeated scrubbings with hot water and soap and with disinfectants, including the final use of the permanganate method, will, if properly executed, ensure complete asepsis of the hands within an hour after the worst exposure.

When summoned to a case of labor immediately after a septic contact, besides the usual care in disinfection, in simple labor all internal examinations may be avoided. In addition to this, it is possible, if thought necessary, to manage the birth even without contact with the external genitals of the patient, the required manipulations being conducted through the intervention of a fresh towel well saturated with the antiseptic solution.

It is impossible, however, to lay down rules which alone will make an aseptic practitioner. The obstetrician must be possessed of an aseptic instinct,

[1] The best preparation of the peroxid of hydrogen is pyrozone.

and this is a matter which comes of training and a keen appreciation of the possible sources and modes of infection.

In hospital practice the obstetrician should, during attendance upon a labor, wear a fresh-laundered gown or a clean apron large enough to prevent contact of his hands with his clothing. His hands and forearms are to be cleansed thoroughly and disinfected before the first examination, and before each subsequent contact with the genitals if they have in the mean time touched anything that is not aseptic.

For the disinfection of the hands the following method, which is substantially that of Fürbringer, is recommended :

1. Clean the nails dry.

2. Scrub the hands and forearms for not less than three minutes with a hand-brush, with soap and water as hot as can be borne. Special care must be taken in brushing the nails and finger-tips, and the water should be changed two or three times.

3. Soak well with alcohol (not below 80 per cent.) and, before it evaporates,

4. Immerse for three minutes in a hot solution of mercuric iodid or chlorid (1 : 2000 to 1 : 500), or in a 3 per cent. solution of carbolic acid.

Undoubtedly, the most essential step in the process is the soap-and-water scrubbing. It not only removes the greater part of the offending material, but it is also indispensable to the proper action of the antiseptic solution. The latter can penetrate the skin only after the oily matter has been removed and after the skin is thoroughly wet. The use of alcohol helps the action of the chemical solution by dehydrating the skin and rendering it hygroscopic, thus favoring penetration of the solution.

Welch, of the Johns Hopkins Hospital at Baltimore, recommends the following procedure, which is known as the *permanganate* method. By it the hands, it is claimed, may be rendered practically sterile to culture tests :

1. The nails are cut short and carefully cleaned.

2. The hands and forearms are scrubbed for three minutes with soap and water. The brush before using is sterilized by steam, and the water, which is as hot as can be borne, is frequently changed. The soap is rinsed off with plain water.

3. The hands are next immersed in a warm solution of permanganate of potassium and are scrubbed with a sterilized swab. Distilled, or at least boiled, water should be used for the solution, which should be saturated.

4. The hands are next held in a warm saturated solution of oxalic acid in boiled water until the permanganate stain is entirely discharged.

5. After rinsing in sterilized water the hands are immersed for two minutes in a 1 : 500 mercuric-chlorid solution.

The Nurse.—The nurse should be no less careful than the obstetrician in the observance of all antiseptic details.

The Patient.—In hospital practice the patient has a bath and a change of clothing at the onset of labor. Before the first internal examination the abdomen, the thighs, and the vulva are cleansed by the nurse with soap and warm water. The soapy water is rinsed off and the parts are well bathed with the antiseptic solution. It is a useful precaution to cover the limbs of the patient, when she takes the bed, with a pair of muslin leggings fresh from the sterilizer. The leggings should be closed below, so as completely to envelop the feet. In addition to this, the patient and the entire cot may be covered with a sterilized gauze sheet. During the first stage a vulvar dressing satnrated with Thiersch's solution may be worn.

Similar precautions are not all practicable in private practice, nor are they all necessary. The change of clothing, the preliminary cleansing and disinfection of the external genitals and adjacent surfaces, and the aseptic cleanliness of everything that comes in contact with the birth-canal must always be insisted upon.

The utility of prophylactic vaginal douches is a question which has provoked much discussion. Steffeck[1] recommends vaginal irrigation during labor with mercuric-chlorid solution at intervals of two hours, rubbing the antiseptic well into the mucous membrane with the fingers.

Döderlein[2] advises scrubbing the vagina with a preparation of creolin and mollin, followed by a ten-minntes' douching with the creolin solution.

Hofmeier[3] favors preliminary disinfection, especially in maternity hospitals where students are allowed to examine the patients dnring labor. He concludes, from a comparison of the records of the Würzburg clinic with the published statistics of other like institutions, that, with preliminary disinfection and the careful observation of all possible antiseptic precautions, instrnction by means of examinations during labor does not necessarily increase the danger of infecting the patient. He further contends that thorough disinfection of the birth-canal is not a source of danger to the mother, as has been claimed, but that it results in a diminished puerperal morbidity and mortality.

Frommel[4] reports over five hundred cases in which vaginal injections of the corrosive-sublimate solution (1 : 2000) were employed, and where in many abnormal cases from sixty to seventy examinations were made during the patient's stay in the hospital, the clinic being open to about one hundred students, and being also used for the training of midwives. In this number of patients there were two cases of sepsis whose infection was traceable to his clinic. The morbidity-rate was from 5.5 to 7.5 per cent. In another series of cases, where external disinfection alone was practised, the morbidity rose to 11.1 per cent.

Mermann[5] reports the results of seven hundred cases without the employment of vaginal douches for preliminary disinfection. He records a morbidity-rate of 6 per cent., with no deaths from septic infection. In the last two hundred births there were two cases of mild ophthalmia, and in all less than ten

[1] "Ueber Disinfection des Weiblichen Genital Canals," *Zeitschrift für Geburtshülfe*, vol. xv. p. 395.

[2] "Disinfection des Geburts-Canal," *Archiv für Gynäkologie*, vol. xxxiv. 111.

[3] *Deutsche med. Wochenschrift*, 1891, No. 49.

[4] *Ibid.*, 1892, No. 10.

[5] *Centralblatt für Gynäkologie*, 1892, No. 99.

of conjunctivitis among the children. Mermann omits internal examinations whenever practicable, observing the progress of the labor by abdominal palpation and auscultation.

Leopold and Goldberg[1] publish the statistics of several thousand deliveries with and without the employment of vaginal disinfection. Their tables show the best results where the vaginal douches were not used. They recommend the employment of abdominal palpation as a means of noting the progress of labor, and the restriction of vaginal examinations to cases of dystocia, except when necessary to confirm a diagnosis made by the abdominal method. They advise douches in operative cases and in all others where previous infection is suspected.

Fischel in an experience of 880 births at the Prague Maternity lost nine women from sepsis with the employment of preliminary disinfection. After stopping the use of the irrigations, in a series of 933 cases there were but two deaths due to infection, and a year later, in 521 women delivered, there were no deaths from that cause.

The safer course, at least for general use, is undoubtedly the restriction of internal examinations as much as practicable, and of the preliminary vaginal douche to cases in which the secretions are pathological. In the presence of purulent gonorrheal discharges both the vaginal and cervical canal, as well as the vulva, ought to be cleansed carefully with soap and water and gentle friction with the fingers, and subsequently washed well with the antiseptic solution. In extreme cases the disinfection may be repeated at intervals of two or three hours during the labor. This is required not only in the interests of asepsis for the mother, but as a prophylactic against ophthalmia in the child. Mercurials, however, are not suitable for the purpose, owing to the danger of mercurial intoxication. Mercury has been found in the stools after a single vaginal irrigation. Some of the non-toxic disinfectants, such as creolin, peroxid of hydrogen, or the chlorinated-soda solution, are to be recommended.

Döderlein has called attention to the litmus-reaction as a ready means of distinguishing healthy from morbid vaginal secretions. He points out that while in health they are strongly acid, in pathological conditions of the secretions their reaction is feebly acid, neutral, or alkaline. These observations have been confirmed by Williams of Baltimore. The litmus-reaction of the vaginal secretions therefore affords a convenient guide to the conditions in which preliminary internal disinfection is indicated.

Antisepsis in the Use of the Catheter.—Should the patient require to be catheterized after labor, care will obviously be needed to prevent infection of the vaginal wounds and abrasions. But this is not all. Cystitis of the vesical neck frequently results from infectious material carried into the bladder during the use of the catheter. So common is this accident that patients who have repeatedly been catheterized by the nurse, even with ordinary precautions, very rarely escape some degree of vesical irritation, and they often suffer from severe inflammation of the bladder or of the vesical neck. Pyelitis may even

[1] *Deutsche med. Wochenschrift*, 1892, No. 13.

result by extension of the septic process from the vesical mucosa through the ureters. The strictest asepsis must therefore be observed in catheterizing the bladder. The instrument should be boiled in water for fifteen minutes immediately before using, and this is possible even with soft-rubber catheters without material injury to the instrument. It should then be handled only with hands that have been previously sterilized.

The patient lies upon the back with the knees drawn apart. The labia are to be held apart, either by the patient herself or by an assistant, so as to completely expose the meatus urethræ, and so held until the instrument is passed. The meatus, the vestibule, and all the surrounding surfaces are to be cleansed with soap and water, and subsequently be washed with the disinfectant solution. The catheter, well lubricated with sterilized vaselin, is then passed with clean hands and with the parts fully exposed to the eye.

Precautions must be used to prevent urine from trickling over the wounded surfaces or into the vagina as the instrument is withdrawn. The catheter, after using, should be cleansed carefully with water. Care must be taken that irritating chemical antiseptics are not carried into the urethra upon the catheter; otherwise a troublesome urethritis may result.

2. Management of Normal Labor.

Essential to the proper management of childbirth is a watchful supervision of the health and habits of the patient throughout pregnancy, and a previous knowledge, so far as possible, of the conditions to be dealt with in each case during labor. Next to Listerian cleanliness, nothing is destined to do more for improved results in obstetrics than the practice, now happily growing with obstetricians, of studying their cases before labor.

It is desirable, therefore, that the pregnant woman be under the observation of her physician from an early period of gestation, and especially if the experience be her first. Much-needed information and advice may be imparted with reference to the hygienic requirements of pregnancy. Knowledge may be gained of conditions likely to complicate the parturient or puerperal process, and much may often be done to fortify the health and strength of the patient.

Dystocia, if it cannot be prevented, is more successfully managed with the aid derived from previous knowledge and preparation. Even when all is normal, both patient and physician are amply repaid for their pains by the increased confidence with which the result of labor is awaited.

The patient should be advised with reference to the selection of her nurse. Instructions will be needed pertaining to the care of the nipples. She should be directed to cleanse them daily during the last month or two of pregnancy, and, if they are very small or sunken, to draw them out with the fingers. This manipulation also helps to inure them to nursing. Daily inunction of vaselin or of fresh cocoa-butter during the same period keeps them supple, and is a better preparation for suckling than the use of astringents so commonly practised.

Especially important is it that the functions of the kidneys be watched. During the last one or two months before labor the urine should be examined weekly. An occasional examination at an earlier period is generally advisable. If albumin be found, the microscopic study of the urine will best reveal the character and extent of the structural changes in the kidneys. In doubtful cases the best evidence of the manner in which these organs are performing their functions is afforded by occasional quantitative tests for urea.

Obstetrical Examination.

In the later months it is the duty of the physician to make a preliminary obstetric examination. The most suitable time is usually about the end of the eighth month. The object is to determine the position and presentation of the child, the relative size of head and pelvis, and the possible presence of pathological conditions that may complicate the mechanism of labor. It is to be assumed that full information has already been obtained, at the time of engaging to attend the patient in confinement, with reference to her obstetric history, including the number of previous pregnancies, term labors, and miscarriages, all important facts pertaining to the character of the pregnancies, labors, and childbed periods, and particulars relating to the course of the present pregnancy.

In hospitals it is the rule to make an external and an internal examination. In private practice an internal examination, while always desirable, need not in all cases be insisted upon. Usually all that is necessary to know may be determined by the external methods. In the presence of pelvic deformity, and in all cases in which for any reason the external examination is not satisfactory, exploration of the pelvic cavity should not be omitted.

It is essential that the bladder and the rectum be empty. The patient lies upon a bed or a lounge, covered with a sheet and with the limbs outstretched. Her clothing is to be loosened and the skirts drawn above the abdomen. The necessary manipulations are conducted under the sheet or through it, without exposure of the patient. In this manner the abdominal examination and the external measurements of the pelvis may be made without causing discomfort or giving offense.

The hands of the examiner are first bathed in warm water to render the skin soft and the touch more acute. This precaution, too, helps to prevent reflex contractions of the abdominal and the uterine muscles, which are more liable to occur when the hands are applied cold to the abdomen.

The examination should be methodical. Errors of diagnosis are more frequently the result of carelessness than of ignorance. Success here, as in most other undertakings, depends upon a capacity for taking pains. All manipulations are to be conducted gently, and need never cause the slightest pain, except rarely when deep pressure is required to map out the lower fetal pole. A definite order of procedure is recommended in accordance with the following scheme :

1. Diagnosis of the Fetal Presentation and Position.

Location of the Dorsal Plane and Small Parts.—The situation of the dorsal plane and small parts of the fetus may, as a rule, easily be made out by palpating the abdomen. The palmar surfaces of the finger-tips are applied with light intermitting touches (Fig. 187). Beginning at the lower part of the abdomen, a narrow zone is palpated entirely across from one side of the tumor to the other. The palpation is repeated over a similar area just above the first, and so on until the entire surface of the tumor has been explored. The situation of the fetus will usually be learned by the first touches. It presents to the examining fingers the feel of a solid body, while elsewhere over the tumor only fluid is felt.

The location of the child may more readily be made out by placing one hand flat upon the middle section of the abdomen and pressing firmly backward (Fig. 188). The liquor amnii is thus displaced to one side and the child to the other, where it can more easily be palpated.

Fig. 187.—General palpation of abdomen for locating dorsal plane and small parts of fetus (from a photograph).

The child's back is identified by the length and breadth of the resisting plane which is offered to the examining touch, and by the absence of a sulcus between it and the fetal head. The side of the child presents a narrower

EXAMINATION BEFORE LABOR: Examination of lower fetal pole (from a photograph).

plane than the back, and a distinct sulcus separates it from the head. The examination of the dorsum is facilitated by applying one hand over the upper fetal pole and pressing downward in the axis of the uterus. The back of the child is thus rendered more convex, and is thrust outward toward the abdominal wall within easier reach of the examining hand.

The small parts are usually felt as nodules which glide about under the touch: they are best identified by circular, rubbing motions; sometimes a fetal member may be mapped out through its whole extent. Except in the case of twins, where there are usually arms and legs in various directions, finding the small parts in one section of the abdomen confirms the location of the dorsal plane in the opposite region. Thus, small parts on the right indicate a left dorsal position, and conversely. Small parts few and hard to find point to an

FIG. 188.—Depressing abdominal walls in locating dorsal plane of fetus in abdominal examination; displacing child to that side of the uterus toward which its back lies, liquor amnii to the other side (from a photograph).

anterior position of the child's back; small parts numerous and found near the middle section of the abdomen usually mean a dorso-posterior position of the child.

Examination of the Lower Fetal Pole.—Facing the mother's feet, place the hands flat upon the abdomen over the lower segment of the uterus (Pl. 23).

With the hands resting upon the sides of the tumor, their palmar

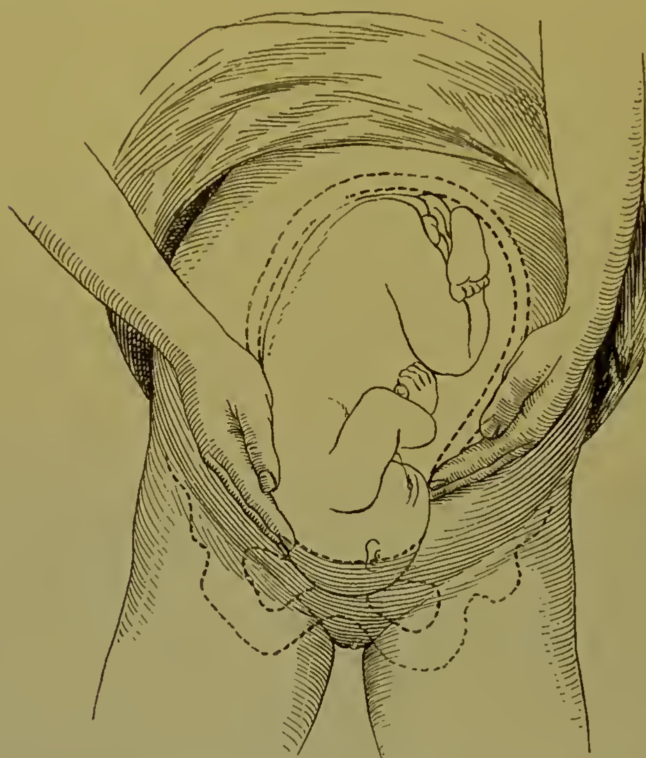


FIG. 189.—Locating cephalic prominence by palpation with both hands. The hand sinks deeper in the pelvis at the side on which the occiput lies (Leopold).

surfaces nearly facing each other and the finger-tips 1 or 2 inches above

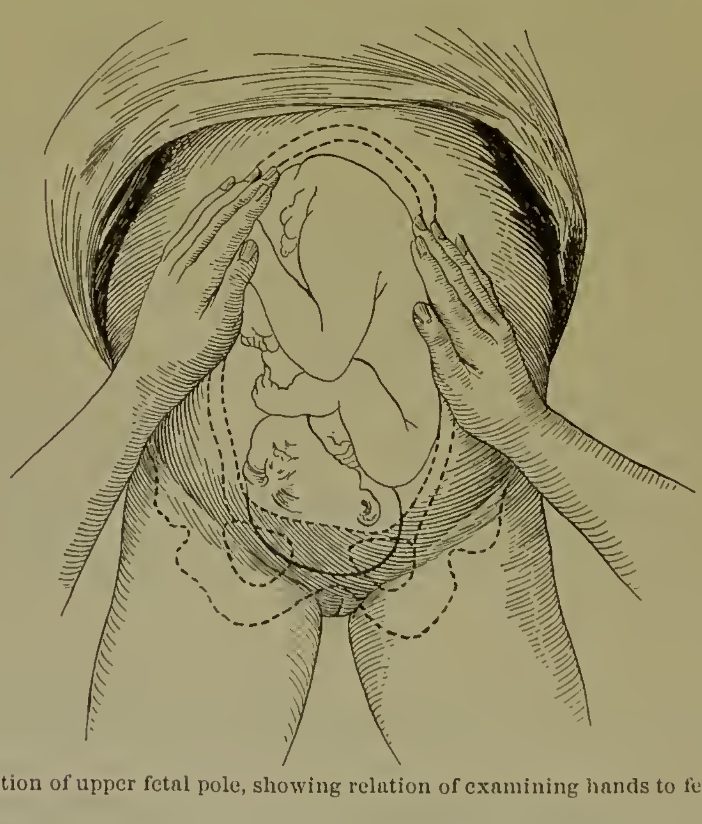


FIG. 190.—Examination of upper fetal pole, showing relation of examining hands to fetal parts (Leopold).

the level of the pubes, maintaining firm pressure, the finger-tips are gently

EXAMINATION BEFORE LABOR: Locating the cephalic prominence by arching the hand across the suprapubic region (from a photograph).

thrust downward into the brim of the pelvis. The pelvic excavation is then explored to learn if it contains the presenting fetal part. If it is filled before labor, the presenting part is the vertex. No other fetal part sinks into the lesser pelvis until labor begins, and even this sinking very rarely occurs except in primiparæ. In the latter the fetal head is normally always in the pelvic brim. During labor either pole, whether the woman has previously borne children or not, should be found in the lesser pelvis.

The head when it lies above the lesser pelvis is not usually so accessible to palpation as when in the excavation. A useful maneuvre for locating the head, if it is not readily found by direct palpation, is to place the hands in the usual position over the sides of the lower uterine segment and proceed as for external ballottement, bringing the hands more and more nearly together until the head is found. The head will be recognized as a solid globular body which can be tossed from one hand to the other.

The cephalic extremity is distinguished from the breech by its greater mobility when it lies above the excavation, by its hardness and globular shape, and by the presence of a sulcus between it and the fetal trunk. The breech alone, is smaller, with the inferior extremities larger than the head. It lacks the hard and globular character of the head, and presents no sulcus between itself and the trunk. An imperfect ballottement of the head is frequently obtainable when it lies in the lower segment of the uterus above the pelvic inlet.

Cephalic Prominence.—When the head is in the excavation one side of the brim will be found more completely filled than the other (Fig. 189). This is due to the fact that the occiput sinks deeper into the pelvic cavity than the sinciput. On one side the frontal portion of the head, on the other side the nape of the neck, occupies the pelvic brim. That side of the cephalic tumor which is the more prominent, therefore, is the sinciput. Cephalic prominence to the right indicates a left, to the left indicates a right, fetal position. The situation of the greater prominence will be observed in the course of the palpation above described. It may also be made out by arching the hand across the abdomen immediately above the pubes (Pl. 24; Fig. 193). The cephalic prominence will be found most marked in occipito-posterior positions.

Location of the Anterior Shoulder in Vertex Presentation.—The anterior shoulder may usually be found as follows: While the hands are still held upon the abdomen over the sides of the fetal head, move them upward toward the fundus without relaxing the pressure. The first obstacle they encounter is the anterior shoulder, which may more fully be identified by mapping it out with the fingers of one hand. Steadying the fetal mass by gentle pressure with the other hand over the breech facilitates the examination. Finding the anterior shoulder within 1 or 2 inches of the median line indicates an anterior, and several inches from the median line a posterior, position of the fetus. In left positions the shoulder lies to the left, in right positions to the right, of the median line (Fig. 192).

Examination of the Upper Fetal Pole.—The examiner next faces the mother's face and places his hands over the sides of the fundus (Figs. 190, 191). The fundal pole of the fetus is then examined by palpation. The head is differentiated from the breech by the characters already

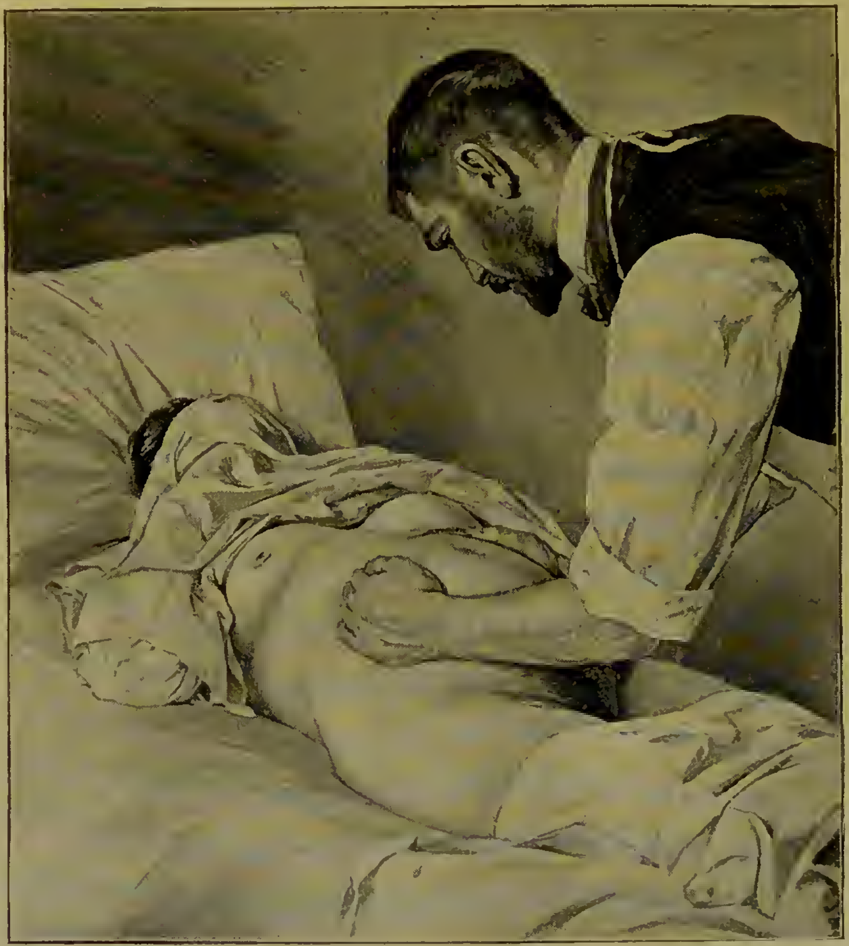


FIG. 191.—Examination of upper fetal pole (from a photograph).

mentioned and by a more pronounced ballottement than is usually possible when the head presents. By reason of its smooth, globular shape, and especially of its flexible attachment to the trunk, the head is very movable, rebounding distinctly under the touch when in the roomy upper uterine segment.

Location of the Fetal Heart-tones.—The stethoscope may or may not be used, according to the usual habit of the examiner. The point at which to listen first is directly over the supposed location of the upper part of the child's back. Failing here, the entire surface of the tumor may be searched.

The heart-sounds are usually heard over an area of about 3 inches in diameter, but, since they are sometimes more widely diffused, it is important to locate the point of greatest intensity. The point upon the abdomen at which they are most intense is termed the *focus of auscultation*. As a rule, this point overlies the fetal heart. Exceptionally, the sounds are most distinctly heard at some remote point, owing to firmer contact of the fetus with

FIG. 192.—Mapping out the anterior shoulder (from a photograph).

the uterine wall at that point. Their location usually serves to distinguish left from right, and anterior from posterior, positions. In a posterior posi-

FIG. 193.—Method of locating the cephalic prominence by arching the hand across the suprapubic region.

tion the heart, if heard at all, is found far back over one side of the abdomen: frequently the cardiac sounds are quite indistinct; rarely they are wholly inaudible.

For the diagnosis of presentation the situation of the fetal heart is of limited value in women who have borne children. Since the position of the heart is nearly midway between the extremities of the fetal ovoid, the mere inversion of the long axis of the child makes little difference in the location of the heart-sounds. In primiparæ, in whom the presenting pole sinks into the excavation in vertex, and rides above it in breech, presentation, the level at which the heart-tones are heard is of some value in determining the presentation. In first pregnancies this level will usually be found below the umbilicus in cephalic, and above it in breech, presentation.

The Location of the Fetal Movements must be taken on the statement of the mother, which statement as an aid to diagnosis is liable to the usual fallacies of subjective signs. It may have some weight, however, in deciding in what part of the uterus the feet lie.

Importance of the Abdominal Examination for the Diagnosis of the Fetal Presentation and Position.—With all the facts clearly made out it will readily be seen that the abdominal examination is of more value for the diagnosis of presentation and position of the fetus than the vaginal touch. Every physician, therefore, should familiarize himself with the technique of abdominal palpation and auscultation in its application to obstetric practice. It is within the power of every obstetrician to become expert in obstetric diagnosis by the abdomen. While the facilities afforded by a hospital service are of great advantage, they are by no means indispensable if proper use be made of the opportunities which even the general practitioner has at his command.

Pathological Conditions.

After determining the presentation and position of the fetus, the abdomen is next to be interrogated for the possible existence of fetal or maternal anomalies that may complicate the labor.

A pendulous abdomen in a first pregnancy should suggest the possibility of pelvic deformity. It not infrequently occurs, however, in multiparæ in whom the pelvis is normal, and it may retard the labor by hindering the engagement of the presenting pole.

Hydramnion is recognized by the increased size and permanent tension of the uterine tumor, by preternatural mobility of the fetus, and by the presence usually of suprapubic edema.

The entire abdomen is explored for the possible presence of pathological growths of the pelvic or abdominal organs.

The location of the placenta may usually be made out by palpation over the abdomen, except when its implantation is mainly upon the posterior wall of the uterus. Its convex edge presents a resisting ring, and the palpation of fetal parts is partially obscured within the placental area. The diagnosis of vicious insertion of the placenta is therefore sometimes possible by abdominal examination.

A hydrocephalic head of a size sufficient to give rise to difficulty in delivery ought to be recognized by external palpation. Its size may be determined more accurately by measurements taken with calipers through the abdominal walls, and by trying whether it can be crowded into the excavation.

In twin pregnancies, as in hydramnion, the abdominal tumor is usually large and persistently tense, and there is suprapubic edema. Indeed, multiple pregnancies are generally associated with excess of liquor amnii. Single feta-

FIG. 194.—Relative location of the posterior superior iliac spines and spine of last lumbar vertebra. The latter is the second vertebral above the level of the iliac spines (after the Ariadne).

tion with hydramnion is distinguished from plural pregnancy by the greater mobility of the fetus in the former. There is a larger number of small parts in plural than in single fetation, and they are more widely distributed. Two dorsal planes and more than two fetal poles may sometimes be made out. One head in the excavation and one in the upper uterine segment or in one iliac fossa make the diagnosis of twins. Two fetal poles more than 12 inches apart cannot belong to the same child. The most conclusive evidence of double fetation is the detection at the same time of two fetal heart-beats of different rates.

Palpation in multiple pregnancy is generally rendered difficult by the permanent tension of the uterine tumor.

2. External Measurements of the Pelvis.

In primiparæ, and in multiparæ in whom the previous obstetric history gives rise to any suspicion of pelvic contraction, the external diameters of the pelvis should be measured. Three measurements are usually sufficient—namely, the external conjugate, the interspinal, and the intercristal.

Of these measurements the most important is the external conjugate (Pl. 25). This diameter is measured from the depression (Fig. 194) just below the spine of the last lumbar vertebra to a point on the pubic surface in front of the upper part of the symphysis. As a rule, it may safely be assumed that the pelvis is ample when this diameter exceeds $7\frac{1}{4}$ inches (18 centimeters),

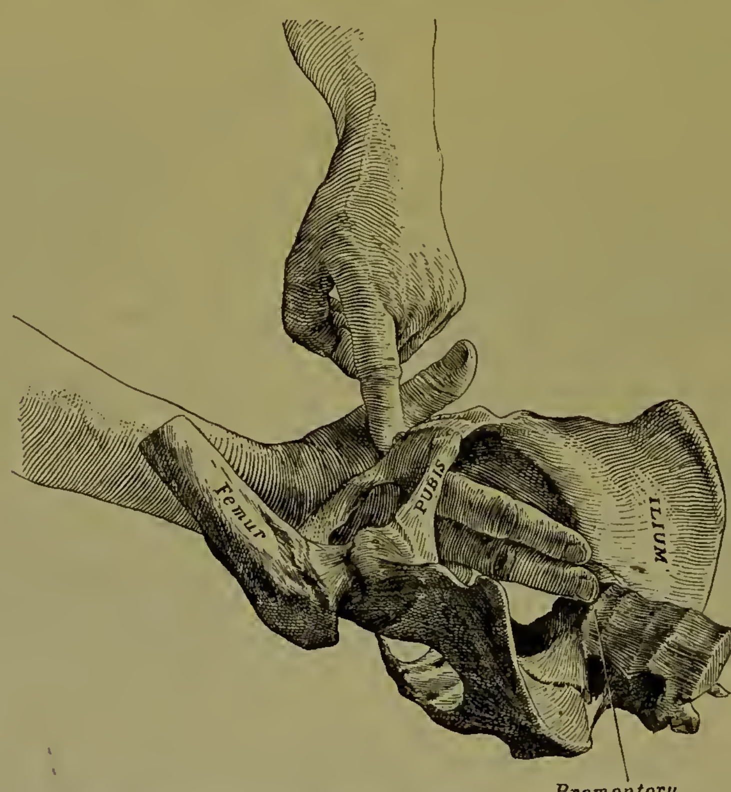


Fig. 195.—Manual method of measuring the diagonal conjugate.

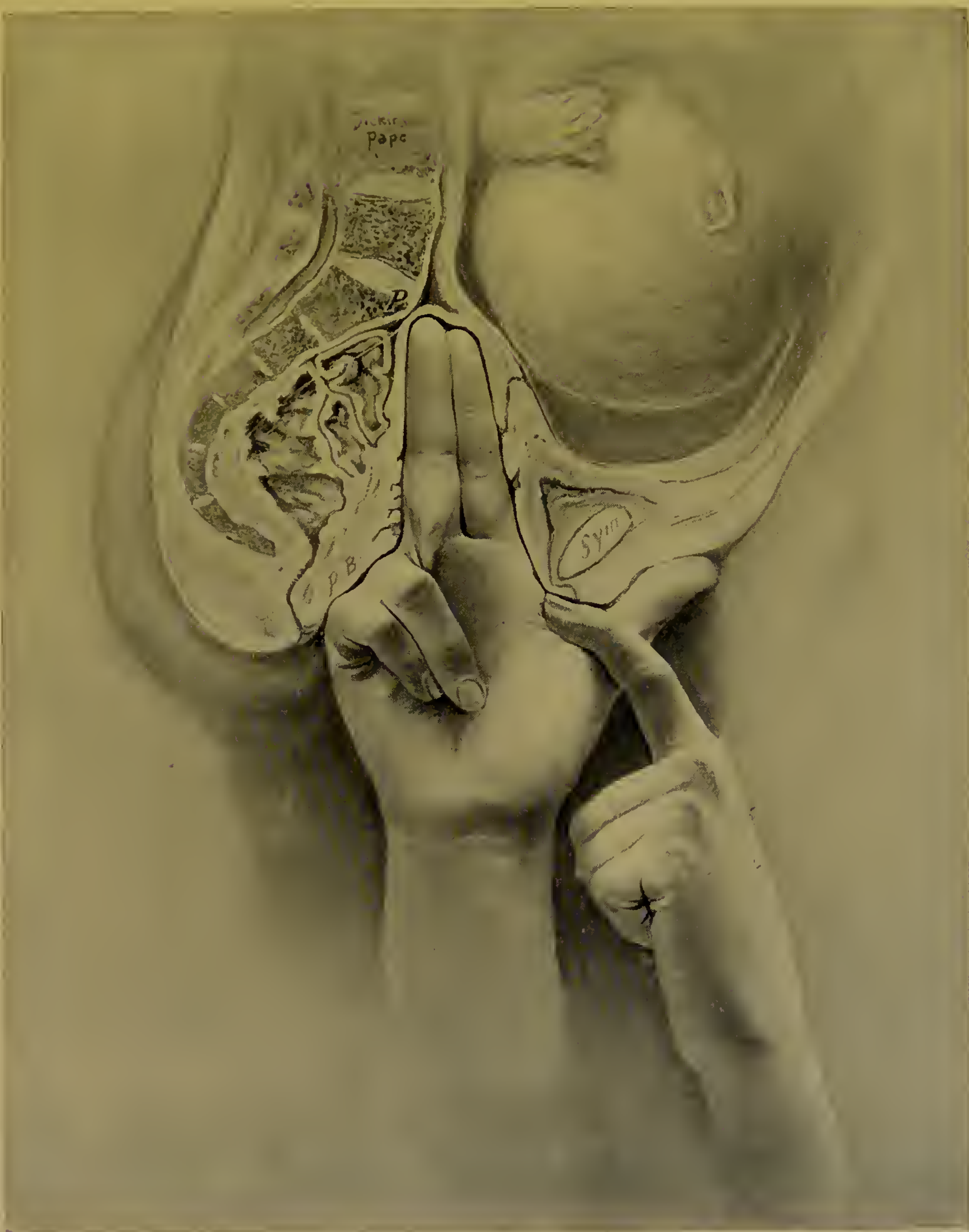
and that it is contracted at the brim when the diameter falls below that limit. Occasionally the sacro-pubic diameter at the brim will be found shortened with an external conjugate of $7\frac{1}{2}$ inches (19 centimeters), and it may be normal when the diameter of Baudelocque is less than $7\frac{1}{4}$ inches (18 centimeters). Contraction in other diameters must be excluded.

An interspinal equal to or greater than the intercristal diameter indicates flattening of the pelvis; when both are small, there is general contraction.

3. Vaginal Examination.

Before examining *per vaginam* the obstetrician's hands and the external genitals of the patient are to be cleansed with the same care that is observed during labor.

Measuring the external conjugate: the black dots show the points from which the measurements are taken (from a photograph).



Manual method of measuring the diagonal conjugate: P, promontory; P, B, perineal body displaced backward.

In parous women the pelvic floor and the cervix are examined for injuries inflicted during previous labors. In all cases the diagonal conjugate and the antero-posterior and bisischial diameters at the outlet should carefully be measured and the width and curvature of the sacrum be noted. The method of measuring the diagonal conjugate is shown in Figure 195 and Plate 26. With the patient in the lithotomy position, two fingers of the examining hand are passed into the vagina, and the tip of the second finger is made to rest by its outer margin against the most prominent part of the sacro-vertebral angle. The point at which the edge of the subpubic ligament cuts the radial border of the examining hand is marked by a finger-nail with the other hand. The distance between the points of contact is the value of the diagonal conjugate. To find the true conjugate the amount to be subtracted from the diagonal is usually $\frac{1}{2}$ to $\frac{3}{4}$ inch, according to the depth and inclination of the symphysis. The diameters of the cavity and the transverse diameter at the brim are estimated by palpating the walls of the pelvis.

The examining hand is to be used wet with the antiseptic solution. If any other lubricant is required, glycerin or vaselin sterilized by heat, or glycerin biniodized or sublimated (1 : 500), may be employed.

The Lying-in Room.

In private practice the patient is generally confined in the room which she is to occupy during convalescence. The choice of room is not a matter of indifference. One of the first requisites of health at all times is pure air, and this should not be denied the patient at a time when the need of oxygen is greater than usual, owing to the severe muscular activity of labor and to the increased tissue-waste of the puerperium. If possible, therefore, a commodious room, one which permits of constant ventilation, should be selected. In cold weather an open fire is an efficient aid to ventilation, and it adds greatly to the cheerfulness of the lying-in chamber.

A sunny exposure is desirable. Dust-laden hangings are especially objectionable, yet it is neither necessary nor best to so far dismantle the room as to make it cheerless. Ordinary cleanliness is usually sufficient.

On no condition should the confinement be conducted in an apartment recently occupied by a patient with erysipelas, childbed fever, suppurating wounds, or other diseases which are recognized sources of possible sepsis, except after systematic cleansing and disinfection.

The management of the patient at the close of labor is simplified if a separate cot be provided for the confinement, the patient being transferred to the bed at the close of the labor.

The Nurse's Preparations.—An orderly nurse will have ready, conveniently near the bed, a small table (Fig. 196) properly equipped with such appliances as the doctor will need for use during the labor. The table should be covered neatly with one or two fresh-laundered towels, and be supplied with a wash-basin, a hand-brush, soap and hot water, an antiseptic solution, scissors, a ligature for the navel, and a suitable aseptic lubricant for the hands.

The nurse should also provide plenty of clean sheets and towels, one or two pieces of unbleached muslin for abdominal binders a half yard in width by one and a quarter yards in length, one or two surgically clean rubber sheets large enough to cover the entire width of the bed, plenty of muslin sheets, a rug or oil-cloth to protect the carpet beside the bed, safety-pins of convenient size for pinning the binder, a fountain syringe, a suitable bed-pan, a supply of hot and of cold water, a package of salicylated or borated cotton for the navel dressing, a blanket for wrapping the child, and the child's clothing.

Preparation of the Bed.—The patient should lie upon a firm mattress. It is customary to protect the bed by means of a rubber sheet, which ought to be large enough to cover the entire width of the bed and the greater part of its

FIG. 196.—Table equipped with basins, brushes, antiseptics, etc., for the physician's use.

length. Over this rubber covering is spread a muslin sheet, the two coverings being pinned fast to the mattress. These spreads are covered with a second rubber overlaid with a bed-sheet. The latter coverings are withdrawn after labor, leaving the bed clean and protected by the first rubber and its muslin covering. Two or three fresh-laundered sheets, each folded to four thicknesses, may be placed upon the bed in position to receive the discharges.

In place of the sheets a good absorbent dressing is a pad specially made for the purpose. It consists of a cheese-cloth sack or bag, which is filled with jute, absorbent cotton, cotton waste, or other absorbent material that has previously been prepared and sterilized. The sack requires to be from $2\frac{1}{2}$ to 3 feet square and 3 or 4 inches thick. The pad is best sterilized by steaming for an hour shortly before use. If a separate cot is used for the confinement, it is to be equipped in the manner above described.

An excellent substitute for the absorbent pad is the Kelly rubber-pad, now commonly employed in gynecological operations. It must be sterilized carefully before using.

It is unnecessary to say that the entire dressing of the bed must be clean in the surgical sense.

The Patient.—The patient should be directed to receive a bath at the beginning of labor and to make an entire change of linen. She will usually prefer to be dressed in her night-clothing, over which, during the first stage, she may wear a loose wrapper. A napkin or a pad kept wet with Thiersch's solution and worn over the vulva during this stage is a simple and useful antiseptic measure.

The Obstetric Bag.—It is recommended that the obstetric bag be large enough to contain all the instruments and other surgical appliances that may be needed in ordinary labors. The equipment should comprise obstetric forceps; a Davidson syringe; a hypodermic syringe; a glass uterine douche-tube; a soft-rubber catheter; a soft-rubber tube with bulb attached for aspirating mucus from the child's throat in case of asphyxia; a half-dozen needles,

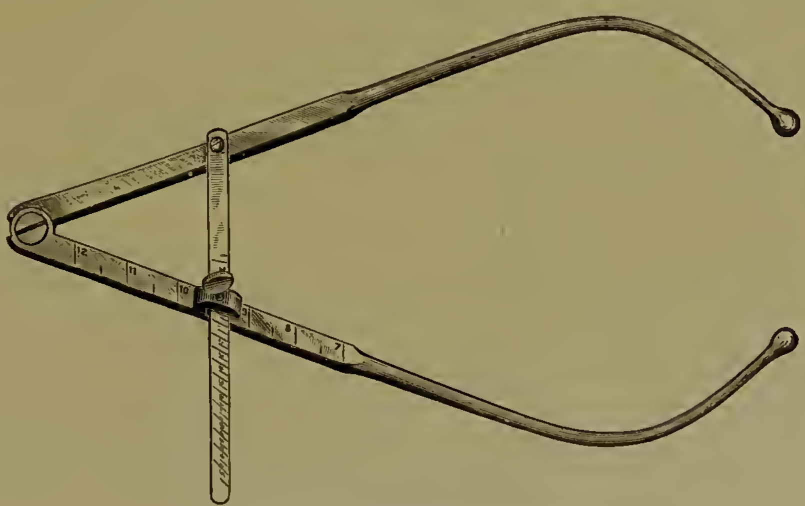


FIG. 197.—Schultze's pelvimeter.

about 2 inches in length and straight or slightly curved, for suturing the perineum; a few short curved needles, an inch to an inch and a quarter in length, for use in the vagina; a needle forceps; a knife for episiotomy; sterilized sutures of catgut, silkworm-gut, and of silk; one or two hand-brushes; a yard or two of iodoform or plain aseptic gauze for possible use in post-partum hemorrhage; a set of Barnes' bags; and a Schultze pelvimeter (Fig. 197).

The additional instruments that will frequently be of service are a Sims speculum, one or two sponge-holding forceps, a volsella, and a curette. A small spring-balance will be useful when it is desirable for scientific or other reasons to know the weight of the child.

The bag should also be supplied with two or three ounces of chloroform, twice as much ether, a few ounces of carbolic acid, and a drachm or two of chloral. Mercurial antiseptics and also obstetric emergents, such as morphin, elaterin, digitalis, ergot, and veratrum viride, are most conveniently carried in tablet form.

3. Anesthesia.

Of anesthesia in obstetrics for the usual surgical indications little need be said. The employment of anesthetics in obstetric operations is governed by the well-established usages of surgical practice.

By *obstetric* anesthesia is understood something entirely distinct and apart from the surgical use of anesthetics. It is intended to diminish, not to abolish, pain. Its object is merely to mitigate the severer sufferings of ordinary labor, not to cause complete insensibility.

To what extent anesthetic agents may be used to advantage in a simple labor is a question that calls for the exercise of tact and judgment. That, on the one hand, obstetric analgesia accomplishes a distinct gain, in so far as it spares the patient the exhausting effects of severe pain and prolonged nervous tension, cannot be doubted; nor has the obstetrician any more pleasing duty than to save the needless sufferings of childbed. On the other hand, except in moderate doses and during the most active period of labor, anesthetics are liable to impede the progress of the birth. The careless and long-continued use of these agents, especially in excessive quantities, is fraught with serious danger to the patient. Their abuse is doubtless at times an unrecognized factor in grave and even fatal accidents of childbed. These objections obtain more especially against chloroform.

With reference to the influence of anesthetics upon the strength and the frequency of the uterine contractions we have some recent observations from Dönhoff.[1] He administered chloroform, in various degrees, to five parturients, studying the effect upon the pains with the aid of a tokodynamometer. Even under small doses the labor was retarded. In eight observations the muscular pressure sank nearly to one-half that present before the administration, and the strength of the uterine contractions was not fully restored for several minutes after the inhalations were stopped.

That the use of anesthetics during labor predisposes, in some degree, to relaxation of the uterus in the third stage, as claimed by Lusk and others, is abundantly exemplified in the writer's experience.

The foregoing facts, while they do not forbid the employment of obstetric anesthesia, call for the exercise of caution in its use. When required for no other purpose then to mitigate the sufferings of the patient, anesthetics should be reserved until the latter part of the second stage, and even then they may be withheld so long as the pains are well borne. Their employment is permissible at an earlier period in the labor when required to subdue great

[1] *Archiv für Gyn.*, Band xlii, 12.

nervousness and excitement or to relieve pains of extreme and unusual severity. In exceptional cases these agents may act to accelerate the labor by counteracting the inhibitory effect of pain upon the uterine contractions.

In the third stage of labor the uses of anesthetics are chiefly surgical. When anesthesia is required to the surgical degree, it must not be assumed that the obstetric patient enjoys any special immunity from the usual dangers of anesthetics. The relative safety of obstetric anesthesia lies not in any peculiarity of the subject, but in the mode of administration, the limited dosage, the slow and gradual inhalation, and the intermittent use of the drug, during the pains only. Under complete anesthesia the parturient woman is exposed to the same dangers as are other patients.

In cases in which an operation must be performed requiring anesthetics, neither disease of the heart, of the lungs, nor of the kidneys, nor the exhaustion of the third stage, forbids their use. These conditions, however, necessitate increased caution in their administration. In cardiac disease, even in lesions of the myocardium, anesthetics lessen the danger by subduing the reflexes.

Choice of Anesthetics.—For mere obstetric analgesia chloroform is generally preferred. It has the advantage of being pleasanter than ether and is less bulky to carry. The latter agent seems to be growing in favor, however, for obstetrical use, and it is claimed to be no less manageable than its rival, chloroform, for partial anesthesia. Hirst thinks analgesia is even more promptly produced by ether than by chloroform. The satisfactory use of ether for this purpose, however, depends upon its proper administration. It must be given very gradually in quantities of a few drops with each inspiration. The difference in the safety of the two agents is insignificant when used in the obstetric method.

When complete insensibility is required for surgical interference, chloroform should, as a rule, give place to ether. The general mortality of chloroform when pushed to the surgical degree is four or five times greater than that of ether. Of the two agents, chloroform is the more potent and its effects persist longer after inhalation stops. Ether, since it is used in larger quantities, is more irritant to the air-passages than is chloroform; hence the former agent should be replaced by chloroform in inflammation of the air-passages, especially if it be acute. Ether is generally believed to be more dangerous in nephritis than is chloroform, but this question is not fully settled. Owing to the tendency of the former agent to produce high arterial tension, it is dangerous in marked atheroma.

Method of Administration.—The patient is prepared for anesthesia by loosening the clothing, by lowering the head, and by attention to such other precautions as are commonly observed in surgical practice. To protect the skin from the irritating effects of the chloroform vapor the lips, nose, and chin may be smeared with vaselin or with glycerin. A towel spread in one thickness over the head, and lifted by the middle so as to form a large air-chamber about the face (Fig. 198), makes a suitable inhaler. An Esmarch mask is also a convenient apparatus for administering the anesthetic in the lying-in room.

On the first premonition of a coming pain the inhaler is placed over the face of the patient, and the anesthetic is dropped upon it opposite the mouth. With chloroform, one drop or, at the most, 2 drops should be let fall at each breath. In case ether is used, 3 or 4 drops with each inspiration will suffice. When sufficient effect is not obtained in this manner, the patient may be requested to breathe rapidly as the pain is coming on.

For convenience in graduating the administration a bottle specially constructed for the purpose may be used, or a dropping-bottle may be improvised by cutting a longitudinal slot in the side of the stopper (Fig. 198).

The foregoing methods of administration ensure abundant dilution of the anesthetic vapors with air and a safe and gradual development of anesthesia

FIG. 198.—Method of giving chloroform with the towel inhaler: the illustration represents the towel as transparent (from a photograph).

with the least possible quantity of the drug. The inhaler should be removed on the approach of unconsciousness, and should always be withheld in the intervals between the pains. During the severer pains at the acme of expulsion the inhalation may usually be pushed nearly or quite to the surgical degree.

Other Anesthetic Agents.—An agent of great value as a partial substitute for the anesthetic vapors is chloral. It is particularly useful for alleviating the pains of the first stage when they are not well borne. From 45 to 60 grains may be given in doses of 15 grains repeated every twenty minutes. The total quantity should not exceed a drachm. Under the full dose the patient usually bears the pains with little complaint, and sleeps quietly in the intervals. Chloral in the quantity mentioned has no inhibitory effect upon the uterine contractions. In disease of the heart, either organic or functional, the wisdom of its employment is questionable, owing to its depressant effect. It is said by some authorities to be unsafe to give chloroform to a patient who is already under the influence of chloral.

The coal-tar analgesics relieve the pains of labor, but they also tend to cause uterine inertia.

The hydrochlorate of cocain applied to the cervix and vagina has proved of little service, its action being merely superficial. It is especially objectionable on the ground that it necessitates interference within the passages.

From an eighth to a quarter grain of the sulphate of morphin, administered hypodermatically, as a rule acts kindly in unusually painful labors, but it is rarely to be recommended in strictly normal conditions.

Examination during the Labor.

The first duty of the obstetrician on reaching his patient in response to her summons is to satisfy himself that she is, as she assumes, actually in labor. The beginning pains, however, are not necessarily to be taken as evidence that active labor is near at hand. Painful uterine contractions are sometimes experienced at intervals for days before the birth. Rarely, after they are fully established, they may wholly cease for hours.

Inquiry is made for the usual phenomena of beginning labor, the time when the pains began, and their character, strength, and frequency. Most distinctive of labor is the rhythmical character of the pains and the contraction of the uterus during the pains as felt by the hand laid upon the abdomen. The first uterine contractions of childbirth frequently give rise to little more than a sense of pressure in the sacral and the lumbar region. As the labor progresses they are felt in front over the lower abdomen, and finally radiate down the thighs. If the labor is in actual progress, a systematic external and internal examination is to be made. The general object and method are substantially the same as in the preliminary examination, with the addition of certain details which pertain more especially to the labor.

The abdominal examination aims to determine whether the child is living, what is the presentation and position, the quality and frequency of the fetal pulse, how far the head has descended in the pelvis, the presence of anomalies that may complicate the birth. The relative size of the head and pelvis can be estimated by observing how far the head has sunk or can be made to sink into the excavation. In doubtful cases measurements of the head may be taken with calipers through the abdominal wall. Distention of the bladder is recognized by palpation over the suprapubic region.

The diagnosis of presentation and position by abdominal palpation is not usually so readily made at this time as before labor, but in most cases it offers no special difficulty. The character of the fetal heart-sounds affords important information as to the prognosis for the child, and they should frequently be listened to throughout labor. A fetal pulse-rate much above or below the normal range, or a pulse which grows progressively weaker, indicates danger to the child.

When a systematic preliminary examination has been made, little additional information remains to be gained by examining internally after labor begins.

For the detection of possible complications that may have developed at the onset of labor, such as prolapse of the cord or of a fetal member, as well as for more precise information of the stage of progress, a vaginal examination is usually desirable, even though the obstetrician be expert in abdominal palpation.

Before examining internally the nurse is directed to cleanse the abdomen, the vulva, and the inner surfaces of the thighs with soap and water, and finally with an antiseptic solution; meantime the obstetrician sterilizes his hands and forearms.

The object of this examination is to learn—(1), the condition of the vulva and the degree of resistance it will be likely to offer as the head descends; (2), whether the vagina is well lubricated by the secretions, and the presence or absence of obstruction; (3), the condition of the cervix, how far dilated, whether dilatable as judged by the extent of softening and thinning; (4), the size and protrusion of the bag of waters; and (5), the presentation and position of the child in confirmation of the abdominal examination.

Vertex presentations are recognized by the hardness and the globular shape of the cranial portion of the head and by tracing the sutures and fontanelles. As the anatomical characters of the presenting part are often somewhat obscured by the caput succedaneum, the examination must be made with care, using firm pressure and searching as far as the fingers can reach. In other than vertex presentations still greater pains will generally be needed to identify the presenting part. During the vaginal examination the hardness of the child's head should be taken into account as an important element in the prognosis. The position is determined by finding in which quadrant of the pelvis the small fontanelle lies. This is best located by first tracing the sagittal suture. (For diagnostic signs of other than vertex presentation the reader is referred to the chapter treating of those presentations.)

The examiner will learn whether the membranes are still intact, and how far they protrude during a pain, and will make sure that a loop of the cord has not prolapsed into the bag of waters. It is perhaps unnecessary to say that in this part of the examination care will be needed lest the membranes be prematurely ruptured.

To the question which is invariably asked, "How long will the labor last?" a guarded answer must be given. Definite predictions are seldom possible at the beginning of labor. The prognosis, so far as it can be estimated, must be based on the strength and the frequency of the pains, the extent of dilatation and the dilatability of the cervix, the position, size, and hardness of the head, and the degree of descent. When nothing abnormal has been discovered assurance should be given accordingly.

Management of the First Stage.

During the first stage of labor the patient ought not, as a rule, to be confined to the bed until dilatation is well advanced. She is usually more comfortable if allowed the liberty of the room, and the pains are thereby promoted. Much walking is not advisable, however, before the head has engaged; it may favor prolapse of the cord or of the small parts, and may hinder engagement. If the membranes rupture or if the pains assume unusual intensity, the patient must be kept in a reclining posture upon the bed or a lounge.

Malpositions are often capable of correction by postural methods, the woman being required to lie upon the side toward which that part of the head points that is to lead the descent. For example, in a right occipito-posterior position the patient should lie upon the right side, and in a left posterior position of the occiput upon the left side.

The clothing should be loose, and be limited to a wrapper and the under-clothing.

If the physician in his first examination has satisfied himself of the absence of complications, the vaginal examination will rarely need to be repeated until after the rupture of the membranes. When the protruding bag breaks before the head is engaged, it is well to make sure that a loop of the cord has not been swept down with the gush of waters. If the first stage is unduly retarded, a careful digital exploration by the vagina may be needed to learn the cause of delay.

The physician's first visit should be prolonged sufficiently to form some estimate of the probable rapidity of the labor and of the length of time before his attendance will again be required. On departing all needed instructions should be left with the nurse. The patient is to be allowed such food and drink as may be necessary, to be warned against voluntary expulsive efforts, and is usually to remain out of bed until the pains are severe. The lower bowel should be cleared and the bladder frequently evacuated.

During this stage it is a general rule for the physician not to remain with the patient until the os has reached the size of a silver dollar. Even after his continuous presence at the house is required, he will better, in most cases, absent himself from the room, except when his attentions are needed by the patient.

Throughout the labor idle bystanders should, as a rule, be excluded from the lying-in chamber. The presence of the husband is a matter to be left to himself and the patient.

Both the maternal and the fetal pulse should occasionally be counted.

All manipulations within the passages for the purpose of accelerating the labor in normal cases are to be scrupulously avoided.

Rarely when the anterior lip of the cervix is caught over the occiput, and apparently retards the progress of the labor, it may be hooked forward during a pain until it retracts above the head. This is a practice, however, that is very liable to abuse.

Management of the Second Stage.

In the second stage of labor, as in the first, so long as all is normal the duties of the obstetrician are few and simple. From the time dilatation is nearly complete the patient must not, as a rule, be allowed to leave her bed, not even for evacuations of the bladder or the bowels. She is to be dressed in the usual night-clothing, which the nurse will keep well tucked under the arms, beyond the reach of soiling. A folded sheet hung like a skirt from the hips still further conduces to cleanliness. When the pains are feeble, their intensity may be increased by requiring the patient to move about in bed or even to assume for a time a sitting or a half-sitting posture. The uterine expulsive efforts should be reinforced by the voluntary muscles. Direct the patient to "hold the breath and bear down with the pains."

Most women during the expulsive pains instinctively brace their feet and catch the hands of the nearest bystander to assist the straining effort by pulling. Except in precipitate labor this practice is to be encouraged. A sheet rolled into a loose rope and fastened by one end to the foot of the bed makes a convenient and efficient sling for the purpose.

An abdominal binder is frequently useful in helping the progress of labor during the second stage, particularly in multiparæ having lax abdominal walls.

The distressing sacral pains so common in the expulsive stage of labor may be relieved in some degree by pressure over the painful region. For this purpose the nurse, taking position on the bed behind the patient as she lies upon the side, supports the back by pressing firmly against the sacrum with the palms of the hands during the pains.

Cramps in the lower limbs are best overcome by powerfully contracting the antagonistic muscles. In case of cramps in the calf of the leg, for example, the patient should forcibly flex the foot and hold it so until the muscular spasm subsides.

Rupture of the Membranes.—When the bag of membranes does not burst spontaneously by the time it reaches the pelvic floor, it should be ruptured by the obstetrician. Care must first be taken to see that a loop of the cord has not slipped down beside the head, as that condition of things would seriously be complicated by the escape of the waters. It is not usually difficult to tear the sac with the finger-nail during a pain. Failing by this method, a sharp-pointed scissors, previously sterilized, may be used. A convenient instrument for the purpose, generally to be found in the lying-in room, is a coarse hairpin. It is first straightened and then well flamed. This perforator is passed on the finger-tip as a guard and a guide, and the bag of membrane is punctured while tense during a pain.

Obstetric Position.—As a rule, the posture of the patient should be left largely to her own choice. Occasional changes relieve fatigue. In simple slow labor the pains are promoted by permitting her to move about in bed and now and then to take a sitting position. Until the head reaches the pelvic floor a half-sitting posture is the most favorable, since the propelling force thus acts most effectively in the line of descent. At the perineal stage the lateral position with the body flexed, which position is most advantageous for the obstetrician, is at the same time advisable from the standpoint of the mechanism. The lower end of the sacrum is tilted backward, and some advantage, perhaps, may be derived from the fact that gravity acts more nearly in the axis of expulsion.

Frequency of Vaginal Examination.—Vaginal examinations should be as infrequent as possible. There is seldom occasion in normal conditions for more than one or two internal examinations, at the most, during the expulsive stage. The descent of the head may be followed by palpating over the lower abdomen until the occiput has reached the floor of the pelvis. From that time the progress of the descent may be noted by the touch through the pelvic floor, and during the last moments of expulsion by ocular inspection.

All that the obstetrician needs to know in normal cases can usually be learned by abdominal palpation and auscultation. Frequent vaginal examinations expose the patient to possible infection in spite of due care in the matter of subjective asepsis. Particularly is this the case when the manipulation extends into the lower uterine segment. Pathogenic bacteria, which are primarily present in the vagina and which remain innoxious in the acid vaginal secretions, may become active when transferred to the alkaline secretions of the cervix or the uterine cavity.

Prevention of Injuries to the Pelvic Floor.—The frequency of pelvic-floor lacerations in term deliveries in general practice may fairly be estimated at about 35 per cent. in first, and 10 per cent. in subsequent, labors. In little less than half this number the injury must be regarded as unavoidable, except by substituting incisions.

In strictly normal conditions the muscular structures of the pelvic floor slowly relax under the pressure of the gradually-advancing head and escape intact. The fourchette, however, is frequently torn in first births. In relatively small vulvo-vaginal outlets and in rigidity of the structures from whatever cause the parts will generally be lacerated during the expulsion of the head in spite of the most skilful efforts of the obstetrician.

The order in which the tissues give way is fascia, muscle, mucous membrane, skin. Accordingly, a laceration may occur subcutaneously, the tear being confined to the muscles and fascia and no breach of continuity appearing to the eye.

Numerous procedures have been proposed for the prevention of perineal injuries during delivery. The discussion in this place of the various methods that have been upheld by obstetric writers would serve no useful purpose. Most of them must be regarded as irrational and useless, if not even mischievous.

When we reflect that the cause of the tear is undue strain upon the resisting girdle through which the head passes at the moment of expulsion, it is plain that any measure to be of value in preventing the injuries in question must do one or both of two things: It must act to promote the relaxation

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and distensibility of the pelvic floor, or to lessen the tension to which it is subjected during the birth, or both. The former object is best accomplished by the slow and gradual delivery of the head, permitting time for the tissues to stretch; the latter, by so regulating the expulsion of the head as to keep its smallest circumference in the grasp of the resisting girdle and the propelling power directed in the axis of the outlet.

The rate of descent is perfectly at command of the obstetrician. The

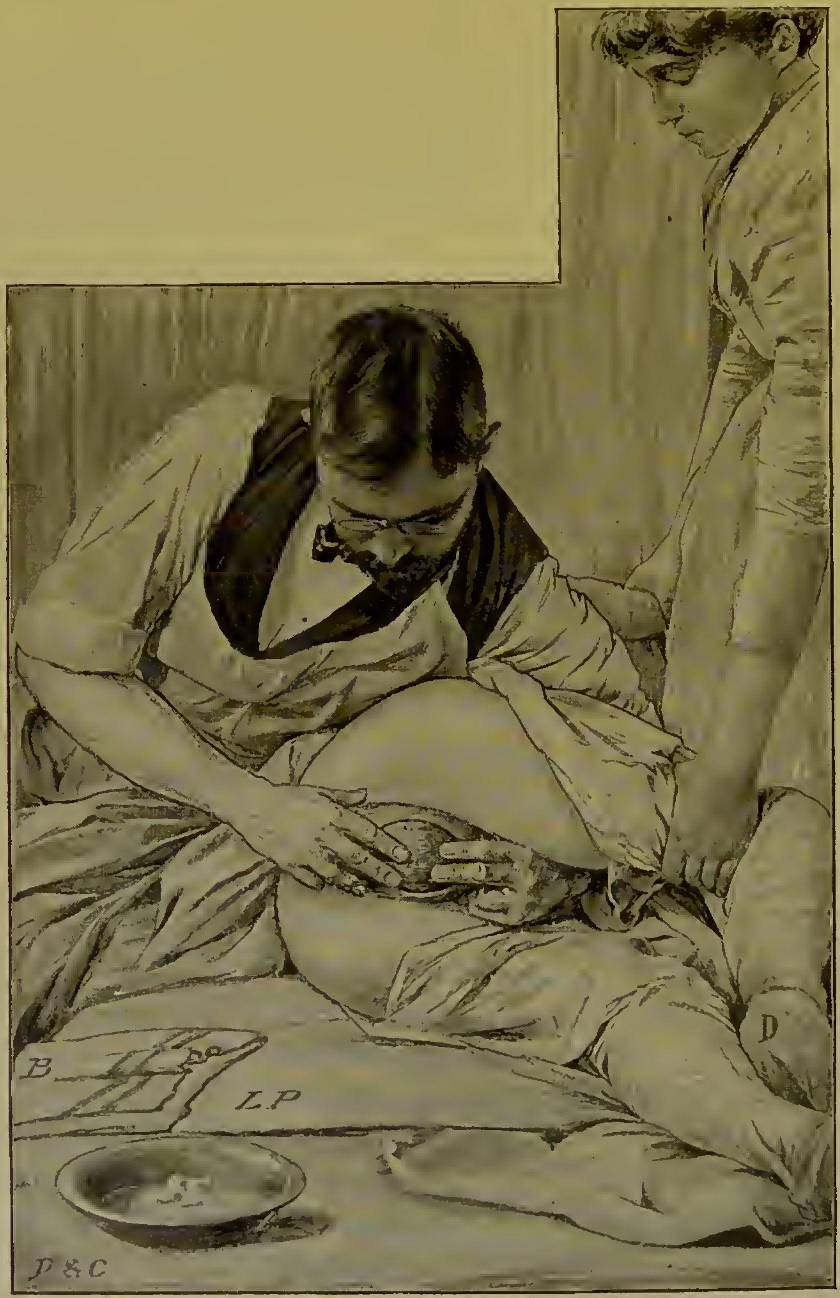

FIG. 199.—Regulating the birth of the head (from a photograph).

expulsive force of the abdominal muscles may sometimes be suspended by requiring the patient to breathe rapidly during the pains. This, however, is not always possible. The action of the abdominal muscles is at this stage frequently involuntary and wholly beyond the patient's control. Most effectual for the regulation of the expelling powers is the use of anesthetics. Chloroform or ether should be given at this period on the appearance of the slightest danger of laceration. By the judicious use of the anesthetic the strength and frequency of the pains and the rapidity of expulsion may be regulated at will.

The advance of the head, however, can still further be controlled by pressure with the thumb and finger held constantly upon the occiput. With the thumb applied to the head immediately in front of the tense border of the perineum, and with two fingers resting upon the occiput, the rate of descent is easily watched and regulated.

To keep the tension of the vulva at a minimum, the long axis of the cephalic cylinder must be kept at a right angle with the plane of the outlet of the soft parts Too rapid extension of the head must be prevented. The forehead should not be permitted to pass the perineum until the occiput is fully expelled and the nape of the neck rests in the subpubic arch.

Moreover, to guard against too great strain upon the pelvic floor, the direction of expulsion must be regulated by crowding the head well up in the pubic arch, especially at the time when the equator of the head passes the vulvar ring. The expelling force is thus directed in the axis of the outlet, and the least possible downward thrust is exerted upon the pelvic floor.

The foregoing manipulations are best conducted with the patient in the left lateral position. In first labors, therefore, and in others in which the perineum is liable to be torn, the patient should, as a rule, be placed upon the left side, with the buttocks close to the edge of the bed, as soon as the head has reached the floor of the pelvis. There is rarely danger of laceration until after the occipital pole appears in the vulvar fissure. Up to this point usually the progress of the perineal stage, when not over-rapid, may be noted by the touch alone. With the finger upon the perineum just behind the posterior vulvar commissure the occiput can be felt through the soft parts some time before it begins to distend the perineum, and the rate of descent can be observed as accurately as by passing the finger within the passages.

From the moment the occiput appears in the vulvar orifice the parts ought to be under ocular inspection. The vaginal discharges are occasionally washed away with a cloth which is kept lying in a warm antiseptic solution. The tension of the resisting ring may be tested by now and then passing the finger within the vaginal orifice during a pain. The head is allowed to advance during a pain until the perineal edge becomes as tense as is deemed safe. Its further progress is then arrested by direct pressure with the fingers in the line of descent (Fig. 200). Until about to be expelled, driven down with the pains, it recedes in the intervals, and by this to-and-fro movement the pelvic floor is moulded as it were to the required degree of distention.

FIG. 200.—Regulating expulsion of the head with the fingers of one hand against the occiput.

When the bregma appears at the edge of the perineum, the head no longer recedes between the pains and is on the verge of expulsion. During the passage of the equator of the head extension must be prevented by upward pressure in the axis of expulsion with the thumb placed upon the sinciput close to the perineum, the fingers resting upon the occiput. The sinciput must not be permitted to advance faster than the occiput. If required for the better control, both hands may be used (Fig. 201).

A favorite method for managing the expulsion of the head is the following: The patient lying upon the left side close to the edge of the bed, the operator, sitting behind her, grasps the head with the fingers of the right hand placed just in front of the fourchette, while the left hand, passed over the abdomen and between the thighs of the mother, seizes the occiput

FIG. 201.—Preferred method for regulating expulsion of the head.

(Fig. 199). This procedure gives easy command of the birth of the head, yet offers no important advantage over simpler methods. The writer prefers to this the manipulation shown in Figure 201.

As a rule, in first labors a half hour or more from the time the pelvic floor begins to be distended will be required before the head can safely be allowed to pass. In subsequent births a shorter time will usually suffice.

While the procedures just described are to be recommended to the general exclusion of other methods, there is no objection to the use of gentle pressure applied to the head through the lateral aspects of the pelvic floor. For this purpose the hand may be laid flat upon the bulging soft parts with the thumb extending along the right, and the fingers parallel with the left, labium. The hand should rest lightly upon the median thinned-out portion of the perineum, the pressure being applied mainly to each side of it. It must be borne in mind, however, that the object is to regulate the expulsion of the head, not to support the perineum. Much compression of the tense pelvic floor, especially its thinned-out median portion, between the child's head and the obstetrician's hand, must tend rather to increase than to diminish the danger of rupture. If the patient lies upon the back during the perineal stage, it will be found more convenient to regulate the expulsion by the thumb placed upon the occiput and the first two fingers upon the head in front of the frenulum.

The introduction of the finger into the rectum for the purpose of shelling out the head, even when practised between the pains, is more likely, as a rule, to cause than to prevent laceration by too precipitate delivery.

It is difficult to understand how the tendency to rupture can be diminished by drawing the perineum forward with the finger in the rectum, as advised by Goodell. As Garrigues has pointed out, an elastic ring encircling a cylinder is subjected to less tension when at a right angle to the cylinder than when oblique. Moreover, interference within the rectum, however practised, is hardly consistent with the requirements of aseptic obstetrics.

Episiotomy.—No method yields better results for the ultimate integrity of the perineum than episiotomy rightly timed and properly executed. The ultimate condition of the pelvic floor after episiotomy correctly performed is even better than after many natural deliveries in which the parts escape rupture. The tonicity of the structures frequently remains as perfect as in the non-parous woman.

The success of the incisions in preventing laceration depends, as already intimated, upon so timing them as wholly to anticipate the tearing, and upon carefully adjusting the location and direction of the cuts. This apparently simple procedure, therefore, is one in which even the accomplished obstetrician may find room for the exercise of skill.

The only instrument required, in addition to what is carried in the usual obstetric outfit, is a blunt-pointed tenotomy knife. When laceration seems inevitable or even probable, the cordlike ring, which can be felt about half an inch above the tense border of the vulva by examination during a pain, should be divided. Locating the resisting girdle by the finger, the knife is passed flatwise between the head and the vaginal wall. The edge of the knife is then turned outward and the ring incised. The operation is repeated on the opposite side. The length of the incision should be about one inch, its depth a quarter-inch, and its location about one-third way from the posterior to the anterior commissure when the parts are on the stretch. The structures involved in the incision when made in this manner are unimportant. They consist usually of the skin, fascia, and probably the bulbo-cavernous muscle.

Most essential is it that the cuts be made parallel with the long axis of the mother's body, not with the vaginal axis. The cuts will then be found on examination after labor to run parallel with the outlet of the birth-canal. If the knife be held in line with the axis of the vulvo-vaginal outlet as the latter appears at the time of incision, its point will be liable to invade the very structures the operation aims to save; the posterior ends of the incisions will be found after delivery much nearer the median line than was intended, and the transversus perinei and other important structures will possibly be divided. This result is well shown in the accompanying illustrations by Dr. R. L. Dickinson[1] (Figs. 202, 203).

FIG. 202.—Double episiotomy (sketch, just after delivery, from nature, R. L. Dickinson): A, direction of incision faulty, pointing toward the posterior vaginal wall; B, correct line of incision, running parallel with the axis of the vulvar opening.

If preferred, the resisting ring may be divided with scissors. After labor the cuts should immediately be reunited with stitches. A running or an interrupted suture with fine catgut best answers the purpose. The wounds may generally be closed without waiting for the delivery of the placenta, thus saving the necessity for renewing the anesthesia. During the suturing the patient may lie on the back or on the side opposite the one being repaired.

Management of the Cord.—The moment the head is born a finger is slipped within the passages to ascertain if the cord is coiled about the child's neck. When so found, the loop or loops should be drawn down one by one over the head. Should the coil be so taut that it cannot be brought down—an accident that must be extremely rare—the cord may be tied at two points, and be cut between the two ligatures and the trunk promptly delivered.

Delivery of the Trunk.—The head should now be held in the hand to keep it in the axis of expulsion. Contrary to the usual teaching, the writer prefers to deliver the posterior shoulder first. While the anterior shoulder lies behind the symphysis the finger is passed over the dorsal aspect of the posterior shoulder and is slipped into the axilla. The posterior shoulder is then folded forward and is cautiously lifted over the perineum.

Except in emergency calling for immediate delivery in the interest of mother or child, the expulsion of the trunk is left to nature. It is not good practice to drag the child out of the uterus. The uterus should be compelled to expel it. The presence of the trunk and the extremities stimulates contrac-

[1] "The Direction of the Incision in Episiotomy," *Trans. Am. Gyn. Soc.*, 1892.

tions, and time is permitted for retraction. When necessary the expulsion of the trunk may be hastened by the use of friction over the uterus.

The frequency with which perineal injuries occur during the delivery of

FIG. 203.—Episiotomy (R. L. Dickinson). Direction of incision: The *black* line shows the direction which the incision should have, as it appears after delivery, in line with the axis of the vulvo-vaginal outlet; the *dotted* line illustrates a faulty incision, dipping into the middle section of the pelvic floor.

the shoulders is probably exaggerated. It is easy to attribute to the shoulders a rupture which had occurred undiscovered during the birth of the head.

On the expulsion of the head the face should be bathed, and the skin about the eyes should carefully be cleansed and thoroughly dried as a preventive against ophthalmia. Mucus in the pharynx should quickly be removed by the finger covered with a piece of soft wet muslin or by the use of a soft-rubber tube with an aspirating bulb attached.

Ligation of the Cord.—The time for tying the cord is by no means a matter of indifference. Systematic observations have shown that the child gains from 1 to 3 ounces of blood by delaying the ligation for several minutes after birth; that in cases thus treated the children are notably more robust than when immediate ligation has been practised, and that the usual loss of weight during the first few days of infancy is diminished.

This post-natal transfusion of blood is a fact of no little importance, especially in prematurely born and anemic or puny children. According to Budin and Ribemont, it is mainly the result of thoracic aspiration. Schücking, Porak, and Fritsch, however, attribute it chiefly to the pressure exerted upon the placenta by the uterine contraction and retraction. Caviglia, who has recently restudied the subject,[1] supports the latter opinion. He calls attention to the fact that since there is frequently a diminution

[1] *Nouvelles Arch. d'Obstet. et de Gyn.*, vii. Année, Nos. 11, 12, et viii. Année, Nos. 1, 2.

of the weight of the child in the first moments after birth from relaxation of the uterus, too early ligation of the cord exposes the new-born infant to the loss not only of reserve blood, but also to a part of its own.

Since the child's heart may be endangered by forcing too much blood into the circulation, compression of the uterus should not be practised before the cord is tied.

In certain emergencies immediate ligation may be necessary, owing to conditions of the mother requiring the obstetrician's entire attention. In case of well-developed, vigorous infants the rule of late ligation loses much of its importance.

The practice now usually observed is to tie the cord after notable pulsation has ceased and the respiration is fully established. If, as seems probable from the researches of Caviglia, the principal cause of the afflux of blood is the uterine pressure, neither the child's respiration nor the funic pulse is the true guide to the time for tying the cord, but rather the first firm contraction of the uterus.

In case of twins the cord should always be ligated on the maternal as well as on the fetal side, owing to the possible existence of a vascular connection between the two placentas.

A suitable material for the ligature is narrow linen bobbin. For greater security against hemorrhage a rubber elastic band may be used. It is perhaps needless to say that the material should be surgically clean. It may be left in the antiseptic solution until wanted.

The common practice is to tie from one and a half to three inches away from the umbilicus. For this rule, in the absence of a navel-cord hernia, there is apparently no better reason than custom. It is in the interest of an aseptic healing of the navel wound to reduce to a minimum the amount of necrotic material in the stump. The ligature should therefore generally be placed not more than half an inch from the cutaneous line. It is to be tied as tightly as it can be drawn, with care to put no strain on the umbilical insertion. Before tying, the cord, except it be already thin, should be pinched firmly between the thumb and finger at the point to be ligated. This procedure is better than stripping, which is liable to do violence to the navel.

The cord is divided within a quarter-inch of the ligature. It is cut with clean scissors while held in the hollow of the hand to guard against injuring the child. A bit of cheese-cloth pressed a few times against the cut end of the stump will show whether the vessels are securely tied. It is a common practice to place a second ligature a short distance from the first to control the maternal end of the cord. This promotes cleanliness and, it is generally believed, favors the placental expulsion. The latter claim, however, is doubtful.

Management of the Third Stage.

Not the least important duties of the obstetrician in the conduct of natural labor fall in the third stage. Upon the skill and attention given to this period the immediate safety of the woman and the rapidity and completeness of her recovery will often in great measure depend. The chief dangers of this stage are those which grow out of a relaxed condition of the uterus—hemorrhage, embolism, and the retention of clots favoring sepsis and subinvolution. The management of the third stage is therefore mainly addressed to uterine contraction and retraction. From the moment the head is born the uterus should constantly be watched, with the hand held flat upon the abdomen over the fundus, until evacuation is complete and the uterine globe as hard as a cricket-ball. After the expulsion of the child the patient is placed on her back. The nurse, if she be competent, may be trusted to hold the fundus, at least while the phy-

Fig. 201.—Credé's method of expressing the placenta, showing also episiotomy incisions (photographed from nature).

sician is occupied with other duties. The hand is to be held quietly upon the abdomen so long as the uterus retains its normal consistence. Should the contractions be feeble, they may be stimulated by gentle friction. This stimulation is best practised by moving the lax abdominal walls over the uterus with a circular motion of the hand. More active interference is seldom required in normal cases. Marked flabbiness of the uterine tumor and indistinctness of outline call for more energetic measures to provoke contraction.

When the placenta is not expelled after a reasonable time, resort should be had to the method of Credé, as follows: A half hour after the termination of the second stage is allowed for the detachment of the after-birth. If at the expiration of that time the placenta is still undelivered, friction is applied to the uterus until a vigorous contraction is induced. The hand is then placed in such position upon the abdomen that the fundus rests in the hollow of the hand with the thumb in front and the four fingers behind (Fig. 204). At the height of the contraction the uterus is compressed and thrust downward in the direction of the pelvic axis. If not at once successful, the process is repeated at short intervals until the object is gained. Until recently Credé advocated much earlier interference. Shortly before his death he recommended waiting thirty minutes. His procedure is now generally adopted. The expectant plan still advocated by certain authorities is open to the objection that the placenta may be retained for hours, during which the patient is exposed to the danger of hemorrhage and is deprived of much-needed repose.

Traction upon the cord while the after-birth lies in the upper uterine segment is inconsistent with the normal mechanism of placental expulsion. When the placenta has passed into the lower segment of the uterus or the vagina, no harm will be done by gently pulling the cord to assist the delivery.

As the placenta is extruded the membranes are gradually detached from the uterus, care being taken that no fragments are torn off and left behind. To prevent this the placenta is caught in the hand as soon as it passes the vulva, and if the membranes are not already free they should be twisted into a rope by turning the placenta over, and the twisting continued until the separation is complete. Should a strip of membrane accidentally be left in the passages, it may be removed, if in the vagina or hanging from the cervix, by grasping it with the fingers and gently drawing it away, or by seizing it with sterilized catch-forceps and twisting it off. Fragments of membranes remaining wholly in the uterine cavity above the cervix are, as a rule, better left to be expelled with the lochial discharge unless they give rise to hemorrhage. Placenta and membranes must be examined carefully to see if they are complete. Possible anomalies of the after-birth or the cord may also be looked for. To make sure that both amnion and chorion are entire the membranes are best examined by transmitted light.

The duties of the obstetrician, even in strictly normal labor, are by no means ended with the delivery of the after-birth. The third stage is not complete until uterine retraction is fully established. For at least a half-hour after the placenta comes away the uterus is to be watched with the hand upon the abdomen, using friction if necessary to provoke contraction. It is a useful precaution to give a half-drachm of the fluid extract of ergot at the close of labor if the uterus is not firmly contracted. Its use is proper only after evacuation of placenta, membranes, and clots. Its action is most prompt and certain when injected subcutaneously. One or two doses may be left with the patient with instructions that they be taken in the event of flowing too freely. The use of a moderate dose of ergot at the close of labor is not only harmless, but it is also entirely in keeping with the objects of treatment at this period. It limits the danger of hemorrhage, and by diminishing the blood-supply it promotes involution. It closes the gates against infection, guards against the retention of blood-clots in the uterine cavity, and therefore lessens the tendency to after-pains and to putrid accumulations in the uterus.

Repair of Lacerations.—*Cervical lacerations* should be sutured at the close of labor in case they give rise to much hemorrhage. In the absence of troublesome bleeding the advantage of the primary suture is doubtful.

The method of operating is as follows. No anesthetic is required. The cervix is most readily brought down within easy reach when the patient is on the back. She may lie across the bed with the hips close to its edge, or still better on a firm table. If necessary, the perineum may be retracted with a large Sims speculum. The anterior vaginal wall may be held up out of the way with a retractor, if required. The cervix is drawn well down with a volsella. The lips of the wound are most conveniently held in contact with a single volsella, one hook being caught in each lip near the lower end of the tear. The first suture should be passed just above the upper angle of the laceration and tied. This suture, if properly placed, controls the bleeding. The other sutures are then applied as in the secondary operation. The material may be waxed silk or silver wire. The former is recommended as being more manageable, and it has, in the writer's experience, proved entirely satisfactory when well saturated with paraffin wax.

Lacerations of the pelvic floor in general practice probably occur in not less than 35 per cent. of first and in about 10 per cent. of subsequent labors. This percentage of injuries, however, is capable of considerable reduction under proper management of the perineal stage of the birth. In skilfully conducted labors the proportion of lacerations should scarcely exceed 15 per cent. In case of relatively small vulvo-vaginal orifice, narrow pubic arch, unusual rigidity of the pelvic floor, in breech extraction, and in other rapid deliveries notable injuries are inevitable in a large proportion of cases.

Fig. 205.—Laceration of the pelvic floor, extending half way to the rectum and running toward the right vaginal sulcus (from a sketch at the close of labor by Robert L. Dickinson, M. D.).

The type of laceration most frequently encountered is one that runs nearly in the median line of the superficial structures and to one side of it in the vagina (Fig. 205). Sometimes the wound presents the shape of a Y with one arm to either side of the median line.

Time for Repair.—Unless the condition of the patient at the close of labor is such as to forbid—and this is very rarely the case—lacerations of the pelvic floor should immediately be sutured. Yet perfect union may be obtained by operating at any time within twenty-four hours. The suturing may generally be done with complete success even after so long a period as a week if for any reason it has previously been neglected. When performed thus late the wound-surfaces are first to be vivified by rubbing them with a fold of cheese-cloth, and then made smooth by trimming with scissors.

The writer has frequently repaired lacerations while waiting for the delivery of the placenta. This practice saves time, and generally, too, the renewal of the anesthesia. It is not to be advised in extensive and complicated injuries.

Suture Material.—For ordinary use prepared silk is recommended. Silk-worm gut or silver wire is less likely to cause suppuration along the needle-track, but neither is so easy of application nor so comfortable for the patient. Catgut is best reserved for buried sutures, owing to its tendency when partially exposed to decompose and to lead septic material into the needle-track.

The writer's method of sterilizing silk by immersion for two hours in melted paraffin at a temperature between 240° and 260° F. has in his hands proved satisfactory. A thermometer specially made for the purpose, which can be kept immersed in the melted wax, must be used for regulating the temperature, otherwise the silk is liable to be overheated and charred. The wax employed should be soft, as the harder varieties crumble in handling the thread. A No. 7 silk is a good size for the larger wounds; somewhat smaller sizes may be used for slight lacerations.

Needles.—For use in the external and more accessible portion of the wound the needle should be straight or be slightly curved and about 2 inches in length. For suturing tears high up in the vagina a needle as much shorter as the depth of the wound will permit, and having a more pronounced curve, may more conveniently be used. Needles of the Hagedorn pattern will be found most satisfactory.

Method.—An anesthetic is usually necessary. Ether is to be preferred here, as usual for surgical anesthesia. Small tears may be repaired under cocain anesthesia if for any reason it is desirable to avoid the use of the general anesthetic. Cocain is most effective when injected at several points in the lips of the wound. Not more than a grain at most can safely be used in this manner, and the solution should be rendered sterile by boiling. Many women, however, suffer very little pain from the introduction of sutures, since the tissues have largely lost their sensitiveness by the pressure and contusion received during labor. If care is taken to plunge the needle quickly through the skin-margin at the moment the greatest amount of pain is produced, lacerations not very extensive may be sutured without anesthesia. The patient lies in the lithotomy position, crosswise of the bed, with the hips close to the edge of the latter, or upon a table. The knees are held by assistants or by some of the numerous appliances commonly employed for the purpose in gynecological practice. The sheet sling of Dr. Dickinson has the advantage of being always available.

One of the chief difficulties in determining the extent and character of the laceration arises from the continuous flow of blood over the parts, obscuring the view. It is generally advisable, therefore, to pack the vagina above the wound with sterile gauze, care being taken to remove it after the operation Loose tags of tissue which might become necrotic should be trimmed off with scissors.

The type of laceration most frequently met with, as previously stated, runs up one or both sides of the vaginal orifice. The aim must be to re-establish completely the normal relations of the injured structures, and when the levator ani muscle has been torn in one or both sulci, especial pains should be taken to bring into close and accurate apposition the torn edges of this muscle. The sutures are to be applied from the skin-surface when the depth of the wound thus included in each suture would not exceed an inch or an inch and a half. The sutures are placed at intervals of half an inch, beginning at the posterior angle of the wound, nearest the anus. Enter the needle upon the skin close to the edge of the wound. Give it a large circular sweep, and let it emerge in the wound well down to the bottom of the tear; then pass it symmetrically through the opposite lip in reversed direction, entering at the bottom of the laceration and emerging on the skin surface at the edge of the wound. Care must be taken to avoid entering the rectum. The course of the suture should be such that when tied the loop shall be nearly circular. Each stitch after insertion is temporarily tightened as if for tying, to see that it has sweep enough to hold the wound-surfaces in contact throughout the entire depth of the laceration. As the threads are placed, one by one, the ends are loosely knotted together or are held with catch-forceps until all are ready to be tied permanently. The gauze packing is then removed and the wound is cleared of clots. The sutures are tied in the order of insertion. They must be drawn tight enough barely to coapt, but not to constrict, the parts. If the sutures are of silk or of equally flexible material, the ends may be left about an inch in length to facilitate removal.

If the sphincter ani is torn, the ends are to be brought together by two or three special sutures. In complete laceration of the sphincter the muscle-ends tend to retract deeply in the tissues. In these cases by close inspection a pocket or depression may be detected in the wound-surface on either side of the median line. This depression marks the location of the retracted end of the torn sphincter. The end of the muscle is to be caught up with a tenaculum and drawn well out as the suture is passed on either side.

Tears involving the vagina to considerable extent should be sutured on the vaginal surface nearly or quite down to the region of the hymen. These stitches are passed at a right angle to the vaginal axis. The rest of the wound is then sutured from the skin-surface as already described, the plane of each of the latter sutures being nearly at right angles to that of the skin.

Complete tears, extending into the rectum, may be stitched on the vaginal, the perineal, and the rectal surfaces. Owing to the difficulty of removing silk from the rectum, rectal sutures should be of catgut. They should include little more than the mucous membrane of the bowel. The rectal side of the laceration is closed first, the knots being tied in the rectum, resting upon its mucous membrane, and the remaining wound is sutured on either the perineal, the vaginal, or both surfaces as may be found most expedient. When the rent does not extend up the rectum too far, in addition to the last interrupted sutures tied in the rectum, which coapt the torn ends of the sphincter, a reinforcing stitch will be useful passed in the following manner: While a tenaculum is used to draw out one retracted end of the muscle, the suture is passed through this end of the muscle, and continues its course upward, buried along the edge of the rectal rent, to the apex of the rent; the needle now emerges, and is again buried along the other margin of the rectal rent, and is carefully passed through the other end of the torn sphincter, while a tenaculum draws out this retracted end of the muscle.

In deep tears of any kind the tiered suture is a good one. Beginning at one end of the wound, a layer of the torn structures at the bottom of the laceration is closed with a running catgut suture; this is repeated in a plane next above the first, and so on until the wound is entirely closed. The last tier of stitches, which is partially exposed on the vaginal surface, is best made with waxed silk. It is well to dust the suture-line with some bland antiseptic powder like boric acid, iodoform, or a mixture of both (iodoform 1 part, boric acid 8 parts). For a few days this application may be renewed with each change of the vulvar dressing. The right and the wrong methods of suturing are shown in Figures 206 to 208.

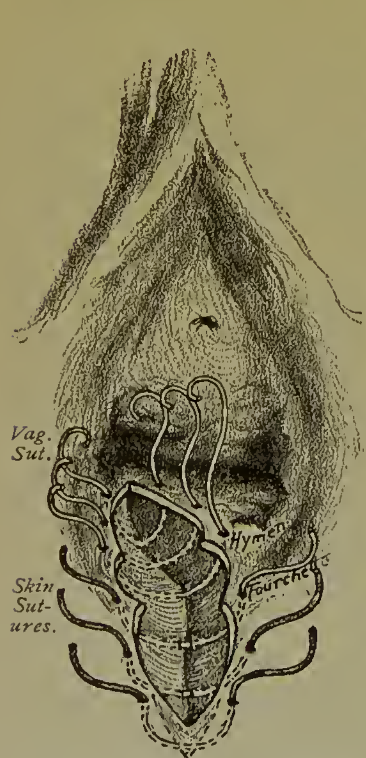

FIG. 206.—Laceration like that shown in Figure 205, with sutures properly placed ready for tying.

After-care.—There is no necessity, as a rule, for tying the patient's knees together. The sensitiveness of the parts will be a sufficient safeguard against injurious strain upon the sutures by separating the limbs, and the patient will be much more comfortable without the leg-binder.

Retention of urine frequently results, owing to the reflex disturbance caused by the perineal suture, especially when the latter comes close to the rectum. While injurious distention of the bladder must not be permitted, the catheter should be withheld if possible. Whether the bladder is emptied voluntarily or otherwise, urine must not be permitted to trickle into the vagina or over the suture-line. The bowels are to be kept open, as in other cases, after the second day. The sutures are removed on the eighth or the ninth day.

Toilet of the Patient.—The child is received in two or three thicknesses of flannel, is well wrapped, and is laid in a warm place. The nurse then turns her attention to the mother: soiled portions of her body are to be cleansed, best with an antiseptic solution; her linen, if necessary, is changed; and all blood-stained articles are removed from the bed. For bathing the genitals a piece of fresh-boiled cheese-cloth or towelling is to be used instead of a sponge. Sea-sponges should be banished from the lying-in room. New sponges are difficult to clean, and the ordinary household article is a nest of filth.

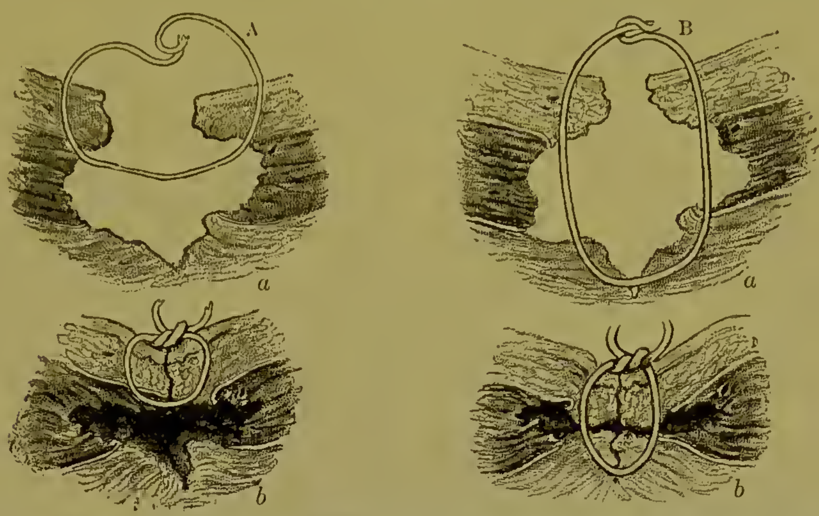

FIG. 207.—A, faulty method of suture, falling short of the bottom of wound and not catching all the muscle-ends: *a*, before tying; *b*, after tying. The latter figure shows dead space at the bottom of wound after tying; perineal body only partially restored. B, suture improperly placed: *a*, before tying; *b*, after tying. The suture (*a*) has too little lateral sweep, and it does not include the ends of all the retracted muscle-fibres at the sides of the wound; *b* shows the result, the pelvic floor being imperfectly restored.

Vulvar Dressing.—After cleansing, the vulva is covered with an aseptic dressing. A fresh-laundered napkin is suitable, or a lochial guard specially

FIG. 208.—Shows full sweep of a properly placed suture: *a*, before tying; *b*, after tying. Even though the tear runs in different planes at different depths, the muscle-ends are held in apposition throughout the entire depth of the wound.

made for the purpose may be employed. These guards are made of absorbent cotton, of cotton waste, or of prepared jute enveloped in cheese-cloth. Suitable dimensions are about 10 inches long, 4 inches wide, and 2 inches thick. Tail-pieces are attached to the guards for fastening to the binder. The guards are burned after using. These dressings are best sterilized by steaming immediately before use. Flowing steam is most effective. They are not employed as occlusion dressings. Their object is rather to promote the cleanliness of the external parts, thus limiting the danger of infecting the passages from the proximity of decomposing discharges. The use of some non-irritant antiseptic like boric acid, bismuth powder, or iodoform helps to retard putrefactive changes.

One rubber sheet should be left in place under the linen for four or five days.

A draw-sheet placed under the patient's hips is a convenient dressing for protecting the bed. The draw-sheet consists of a common muslin sheet folded to four thicknesses. It is replaced by a fresh one as often as soiled. Instead of the draw-sheet an aseptic pad similar to the labor-pad, but thinner and smaller, may be preferred.

Abdominal Binder.—The abdominal binder is useful to steady the uterus, and it promotes the comfort of the patient, especially when the abdominal walls are very lax. The usual material is a piece of unbleached muslin $1\frac{1}{4}$ yards in length and about 18 inches in width. This gives width enough to reach from the ensiform to a point below the trochanters (Pl. 27, Fig. 1). Unless the binder overreaches these bony prominences it is liable to slip up, and in a few hours is reduced to a mere rope around the body. Binders ready made with gores to fit the body offer no advantage. The pinning of the binder should begin at the lower border, and at the first application should be fairly tight. If the uterus shows any tendency to relaxation, three folded towels, used as compresses, may be placed on the abdomen under the bandage, one on either side of the uterus and one immediately above it. The binder may be dispensed with after one or two weeks.

Before leaving it is well for the physician to take final note of the pulse and the general condition of the mother, and the nurse should receive all needed instruction in regard to the general care of both patients.

III. THE MECHANISM OF LABOR.

LABOR is a natural process, and it is the province of the accoucheur to restrict himself to watching the processes of nature so long as they are normal and efficient, and to interfere with them only when they become disturbed or inefficient. He is at his best when he is able to compel the faulty efforts of natural labor into a normal course, and he makes a comparative failure whenever he is obliged to substitute for the acts of nature the relatively crude process of an artificial delivery. An ability to restore the normal by making trifling alterations in the mechanical conditions presupposes, however, a most accurate knowledge of the details of the mechanism which governs the usual course of labor, and of the alterations in them which determine the advent of any deviation from the normal. When, moreover, it is remembered that obstetric operations are but efforts to direct an extraneous force into an accurate imitation of the processes of nature, it becomes evident that the first essential to success in obstetrics is the possession of a far-reaching knowledge of the mechanism of labor in its several varieties.

Any intelligent study of obstetrical mechanism must, however, be preceded by a comprehension of the technical terms used in describing it, and of the several classifications by which labor is commonly subdivided into varieties. It is further necessary that the student should possess an accurate knowledge

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1. Abdominal binder and breast-binder in place (from a photograph). 2. Breast-binder in place (from a photograph).

of the shape and dimensions of the obstetric canal, and of the fetus which is to pass through it. He is then in a position to acquire an intelligent understanding of the principles which underlie the mechanism of all the forms of labor, under the head of a description of its commonest variety, and so easily goes on to understand the modifications in the mechanism that follow upon the alterations in the conditions in the other varieties.

Attitude of the Fetus.—By the attitude of the fetus is meant the position its parts assume *in utero* in relation to one another, in contradistinction to any relation they may bear to the maternal parts.

During the earlier months of pregnancy the uterine cavity is nearly spherical in shape, and it is then so large in proportion to the fetus that its walls are rarely in contact with the embryo. The fetus hangs freely in the uterine cavity, being suspended by the umbilical cord, with its head somewhat lower than its pelvis and with its limbs in a somewhat extended position (Fig. 209). As pregnancy progresses the size of the fetus increases more rapidly than that of the uterus, until in normal cases at term the adaptation

FIG. 209.—Relation between the size of the uterus and the fetus at fifth month (fetus oue-sixth natural size).

FIG. 210.—Adaptation between the uterus and the fetus at term, in vertex presentations (one-sixth natural size).

between the two is sufficiently close to make any extended movements of the fetal limbs difficult or impossible. The attitude which the child then assumes is that represented in Figure 210, which is readily seen to be the most compact attitude in which the child can be arranged.

Presentation.—The word *presentation* is used to define the relation which the long axis of the child bears to the long axis of the uterus, and the different presentations are distinguished from one another by the use of adjectives which refer to the part of the child that is to enter the pelvis first in a given case. The several presentations which may occur are cephalic presentations—that is, presentations of the vertex, of the brow, and of the face; presentations of the pelvic extremity, which are subdivided into breech and footling presentations; and transverse presentations, under which are included presentations of the hip, of the trunk, and of the shoulder.

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Position.—In obstetric use the word *position* is restricted to a meaning in which it is used to define the relation that the dorsum of the child bears to the dorsum of the mother during its passage through the pelvic canal. Each presentation is subdivided into positions according as the dorsum of the child is directed anteriorly or posteriorly and toward the right or the left side of the mother. Thus we recognize under each presentation four positions, according to whether the part which gives the name to the position is directed left-anteriorly, right-anteriorly, right-posteriorly, or left-posteriorly; for example, vertex presentation, occipito-left-anterior, breech presentation, sacro-right-posterior.

Classification of Labor.

Presentations.—The presentations are first of all roughly divided into *longitudinal* and *oblique* presentations. The longitudinal presentations are those in which the long axis of the fetus is in correspondence with the long axis of the uterus; the oblique presentations are those in which there is a considerable angle between the two axes.

The longitudinal presentations are, then, those in which either the cephalic or the pelvic end of the fetus is found at the inlet of the pelvis at the beginning of labor—that is, all the variations of cephalic and pelvic presentations.

The oblique or transverse presentations include all those in which any portion of the fetus other than the head or the breech is found at the pelvic brim.

Head presentations are divided into those of the vertex, of the brow, and of the face. Pelvic presentations are divided into *breech* presentations, in which both thighs are flexed upon the abdomen when the nates of the fetus enter the mother's pelvis, and *footling* presentations, in which one or both legs are extended and enter in advance of the infant's pelvis. Transverse presentations include presentations of the hip, of the trunk, and of the shoulder; among these presentations those of the shoulder are by far the commonest and most important.

It is also convenient to classify the presentations of the fetus in two other ways, in accordance with the results which may be expected to accrue from their occurrence—namely, into *normal* and *abnormal, natural* and *unnatural,* presentations.

Normal and Abnormal Presentations.—A presentation of the vertex occurs in about 97 per cent. of all labors, and, both from its frequency and from the favorable character of its results, is considered to be the only normal presentation, all others being classified as abnormal.

Natural and Unnatural Presentations.—Natural presentations are those in which the conditions are such that they may be expected to terminate, in a large proportion of cases, in delivery by natural or unaided labor. Unnatural presentations are those in which the shape of the presenting part of the fetus is so ill-adapted to the pelvic canal that the labor can ordinarily be terminated only by the intervention of the obstetric art, natural delivery being possible only when the pelvis is exceptionally large and when the fetus is at the same time immature or exceptionally small. Vertex, face, and breech presentations are classified as natural; brow and transverse presentations are classified as unnatural.

Position.—A division of the presentations into varieties in accordance with the obstetrical positions is a matter of the utmost practical importance, as the mechanism and treatment of labor, and, indeed the prognosis, are often radically different in the several positions of a given presentation. For convenience the most prominent point on the dorsal side of the presenting part is selected for the denomination of the position in each presentation,* in accordance with the relation it bears to a cross-section of the inlet at the beginning of labor.

Vertex.—Vertex presentations are thus divided into positions in accordance with the quarter of the pelvis in which the occiput is found at the beginning of labor. We recognize in vertex presentations four positions: Occipito-left-anterior; occipito-right-anterior; occipito-right-posterior; and occipito-left-posterior.†

Face.—In face presentations the position is named from the position of the chin. The positions are mento-left-anterior, mento-right-anterior, mento-right-posterior, and mento-left-posterior.

Brow.—In brow presentations the positions are somewhat unsatisfactorily classified from the position of the occipital end of the head, as—brow, occipito-left-anterior; brow, occipito-right-anterior; brow, occipito-right-posterior; and brow, occipito-left-posterior.

Breech.—In breech presentations the names of the positions are determined by the situation of the sacrum, as—sacro-left-anterior, sacro-right-anterior, sacro-right-posterior, and sacro-left-posterior.

Transverse.—In shoulder presentations the positions are named from the situation of the presenting scapula, as—scapular-left-anterior, scapular-right-anterior, scapular-right-posterior, and scapular-left-posterior.

For convenience the names of the various positions have long been designated by a conventional set of abbreviations, which are commonly used without the name of the presentation, that being included by implication. The abbreviations now in general use are those which were determined upon by the last International Medical Congress in its session at Washington, D. C. They are as follows: Occipito-left-anterior, O. L. A.; occipito-right-anterior, O. D.‡A.; occipito-right-posterior, O. D. P.; occipito-left-posterior, O. L. P.; Mento-left-anterior, etc., M. L. A., etc.; sacro-left-anterior, etc., S. L. A., etc.; scapular-left-anterior, etc., Sc. L. A., etc.

* Except in face presentations, in which case the chin is chosen on account of its prominence in the mechanism of this variety of labor.

† The older obstetricians were accustomed to recognize four other varieties, in which the occiput was respectively directly posterior, directly anterior, left transverse, and right transverse. It is now held, however, that these positions do not occur, under normal conditions, in normal pelves. Since they are only found in some varieties of deformed pelves and in some other pathological conditions, their consideration is now commonly relegated to the domain of pathology.

‡ Dextro.

Anatomy of the Pelvis.

The anatomy of the bones and the soft parts which together make up the pelvis is described in detail in another portion of this work, but for the comprehension of the mechanism of labor it is necessary to add to the anatomical description a discussion of the shape and dimensions of the parturient canal as a whole, before its mechanical relation to the fetus which is to pass through it can intelligently be discussed.

The parturient canal (Fig. 211) may be divided, for purposes of description, into three parts—the *suprapelvic*, the *pelvic*, and the *infrapelvic* portions.

Fig. 211.—The parturient canal: AU, axis of uterus; AI, plane of inlet; RR, retraction-ring; IO, internal os; EO, external os (one-third natural size).

The *suprapelvic* or abdominal portion of the parturient canal is made up of the uterine cavity and the large or false pelvis. This portion of the pelvis is classified with the uterine cavity on account of the similarity of their functions; that is, the obstetric function of the large pelvis is simply that of affording a resting-place to the lower portion of the child during the whole or the greater portion of pregnancy, and of guiding the presenting part to the inlet at the beginning of labor. The *pelvic* portion of the parturient canal consists of the small or true pelvis. The *infrapelvic* portion is made up of the soft parts lying below the pelvic bones, which parts, though small and inconspicuous in the non-parturient state, are stretched out during labor into a tubular canal which considerably prolongs the parturient canal, and completes the curve of its lower portion, known as the *curve of Carus.*

An adequate comprehension of the shape and the mechanical functions of the parturient canal in its entirety will best be attained by postponing the description of the canal as a whole until its subdivisions and component parts have been described in detail.

Suprapelvic Portions.—*Uterine Cavity.*—The uterus at term is a hollow, ovate-shaped viscus, whose cavity, although anatomically a part of the parturient canal, is, from a mechanical standpoint, less a part of the passage than the engine by which the passenger is to be propelled. The function of the uterus as the source of the propulsive power by which labor is accomplished will be discussed later. Its function as a portion of the canal requires no special description.

False Pelvis.—The false or large pelvis is that portion of the pelvis lying above the linea terminalis. It is composed of the lumbar vertebræ, the upper surfaces of the lateral processes of the first sacral vertebra, and the squamous portions of the iliac bones, and functionally it is completed by the lower portions of the anterior abdominal muscles and their attachments to the horizontal rami of the pubic bones. The whole thus forms a funnel whose sloping walls terminate in the inlet of the true pelvis, and are admirably suited to their office of directing the presenting part into the pelvis in the initial stage of labor. Apart from this point, the chief practical value of the false pelvis is in the light which alterations of its shape or of its dimensions throw upon the diagnosis of pelvic deformities. To be in a position to detect any departure from the normal shape of the pelvis, it is especially important to be familiar with the normal shape of the iliac crests and with the normal curve of the linea terminalis.

Although the crests of the ilia are classically described as presenting an S-curve, it must be remembered that only one portion of this curve—namely, that which possesses an anterior concavity—enters into the formation of the basin of the false pelvis; the other portion of the curve is entirely without the pelvis, and is utilized solely for the attachment of the sacro-iliac ligaments and the erector spinæ muscles. The shape of the anterior portion of this curve is such that the greatest distance between the crests is normally 2.5 centimeters (about an inch) more than the distance between the anterior superior spinous processes, the distance between the crests being normally 25 centimeters (about 10 inches), and that between the spines 22.5 centimeters (about 9 inches).*

Under normal circumstances the anterior portion of the linea terminalis

* These dimensions are found to be somewhat variable among different races. The figures given are believed to be approximately correct for American women.

presents a uniform curve with an internal eoneavity, and there is but little, if any, projection of the erest of the pubes in or about the median line.

Pelvic Portion.—The true or small pelvis eomprises all that portion of the pelvis lying below the linea terminalis, and it is divided into three portions —the superior strait or inlet, the inferior strait or outlet, and the excavation. It is formed by the saerum, the eoecyx, the lower portion of the ilia, the isehia, and the pubes. These bones taken together form a deep basin-shaped cavity, whose posterior wall is formed by the sacrum and eoeeyx and is

Fig. 212.—Pelvis seen from above, showing the decrease in the transverse diameter from above downward (one-third natural size).

sharply eurved with an anterior coneavity. The anterior wall is formed by the symphysis, and is short and nearly straight. The lateral walls, which are formed by the lower portions of the ilia, the isehia, and parts of the deseending rami of the pubes, are irregular in outline and slope gently inward, so that the transverse diameter of the pelvis is markedly less at their lower than at their upper extremities (Fig. 212).

At its upper and lower limits, whieh are known as the *superior* and *inferior straits* (Fig. 213), the dimensions of the pelvis are mueh less than in the intervening spaee, ealled the "excavation." An aeeurate knowledge of this portion of the parturient eanal is of the greatest importanee, and on aeeount of its eomplexity is most easily given by separate descriptions of the exeavation and of each of the straits, after whieh description it will be easy to include that of the pelvis as a whole in the general deseription of the parturient canal that follows at the end of this section.

The superior strait is bounded by the promontory and the anterior surfaee of the first saeral vertebra, the linea terminalis, and the pubie erests. The shape of the inlet or superior strait of the pelvis varies eonsiderably in aeeordance with the point of view seleeted, but if the eye of the observer is placed in the probable position of the axis of the child at term, it will be seen that the shape of the inlet is approximately eireular (Fig. 212).

It must be remembered that the presence of the soft parts somewhat alters

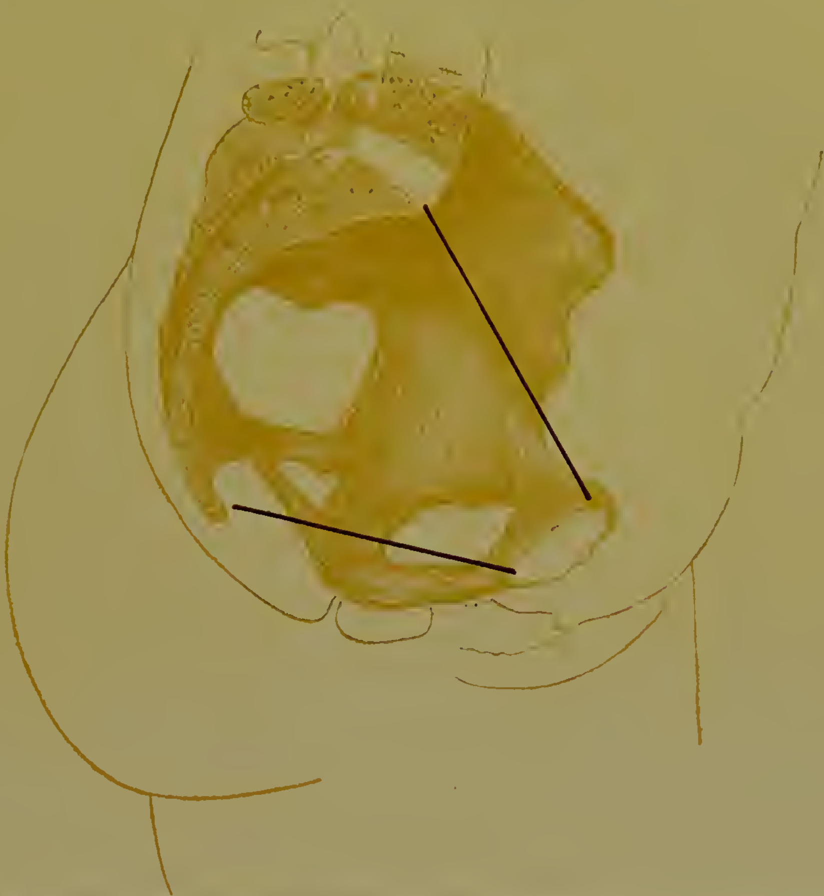


FIG. 213.—Lateral view of the pelvis, showing superior and inferior straits (one-third natural size).

the shape of the brim. The importance of this fact, however, is lessened by

FIG. 214.—Pelvis seen from above, showing diameters of brim (one-third natural size).

the fact that the vessels, the connective tissues, and the rectum, as well as the psoas-iliacus muscles, which together form the only important soft parts in the inlet, are concentrated in the sacro-iliac notches, where the space is already most abundant and where its decrease is of least importance.

The dimensions of each of the straits are determined by measuring the antero-posterior, the transverse, and the two oblique diameters. The antero-posterior, or, as it is more commonly termed, the *conjugate*, diameter of the superior strait (Fig. 214) extends from the upper border of the symphysis pubis to the promontory of the sacrum; its normal length is 11.5 centimeters (4½ inches). A little less than half an inch from the upper border of the symphysis pubis is found a point which, owing to the thickness of the pubic bone, is decidedly nearer to the promontory than the upper border itself. From the promontory to this point the distance is 11 centimeters (about 4¼ inches), and this is called the "obstetrical" diameter or true conjugate.

The greatest transverse diameter of the superior strait averages 13.5 centimeters (5⅜ inches) in length; this is the diameter referred to whenever the transverse diameter of the superior strait is mentioned. This diameter lies, however, so far back in the pelvis—that is, so near the promontory (Fig. 214)—that it can never be occupied by any of the diameters of the fetal head. The transverse diameter, which could, in fact, be occupied by the fetal head, lies some distanee anterior to this, and is so much shorter as to be of little importance, being, in fact, less than are the oblique diameters. In point of fact, the head never enters a normal pelvis transversely, and the transverse diameter is therefore measured merely as a means of comparing one pelvis with another.

The oblique diameters extend from the ilio-pectineal eminences to the sacro-iliac articulations; their length is 12.75 centimeters (about 5 inehes). Since the terms *right* and *left* oblique diameter are differently used by different authorities, it seems best to distinguish these diameters as the *first* and *second* oblique diameters of the inlet, in accordance with the frequency of their importance in the mechanism of labor; the first being that which extends from the left ilio-pectineal eminenee to the right sacro-iliac synchondrosis.

The inferior strait is bounded by the subpubic ligament, the descending rami of the pubes, the rami, tuberosities, and spines of the ischia, the sacro-sciatic ligaments, and the eoccyx. Its shape, when looked at in the direetion of its axis, is that of a lozenge whose anterior sides are formed of the pubic and ischiatic rami, while the posterior are made up of the sacro-sciatic ligaments.* When looked at from a point somewhat anterior to the line of its axis, it is seen to present a roughly triangular shape; but when we remember that the sacro-sciatic ligaments become very distensible during labor, and that the softening of the sacro-iliac and saero-coceygeal articulations that occurs

* Owing to the projection downward of the tuberosities of the ischia, it will be seen that the surface of the inferior strait is bent upon itself to form an external convexity (Fig. 215). For practical purposes it is, however, convenient to neglect this bend, and to deal with the inferior strait as though it did, in truth, lie in a plane between the tip of the coccyx and the subpubic ligament.

during pregnancy permits of a considerable movement of these bones upon each other, it will be seen that when the soft parts of the inferior strait are

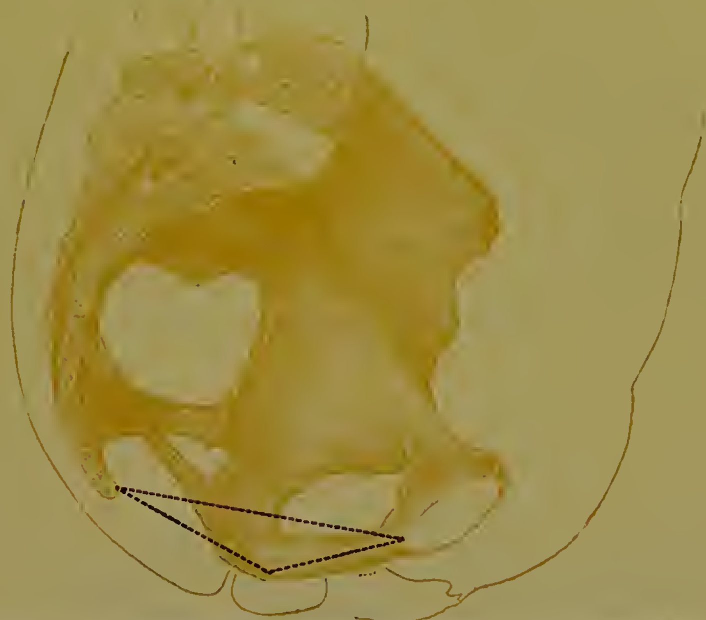


FIG. 215.—Lateral view of the pelvis, showing external convexity of the inferior strait.

distended by the head, its aspect from either position will be that of an ovate or egg-shaped orifice (Fig. 216).

The antero-posterior diameter of the inferior strait extends from the lower border of the symphysis to the extremity of the coccyx. Its length in the non-parturient state is 9 centimeters (about $3\frac{1}{2}$ inches), but when the move-

FIG. 216.—View of distended outlet. The dotted lines show the possible position of the sacro-sciatic ligament and the consequent increase in the transverse diameter during extreme distention.

ments of distention spoken of above are fully effected, the length of this diameter is increased to 11 centimeters ($4\frac{3}{8}$ inches), or perhaps even to 12 centimeters ($4\frac{4}{5}$ inches).

The transverse diameter, which is drawn between the inner borders of the tuberosities, measures 11 centimeters ($4\frac{3}{8}$ inches), and it is the only unyielding diameter of the inferior strait. The divergent direction of the tuberosities makes it possible, however, for the transverse diameter of the head to correspond with a much wider transverse diameter of the outlet whenever the conditions of the case permit the parietal protuberances to occupy a position posterior to the tuberosities (Fig. 216).

The oblique diameters are manifestly rendered unimportant by the uncertainty as to their length, the result of the elasticity of the sacro-sciatic ligaments.

The excavation, which is bounded by the inferior and superior straits, comprises all that portion of the pelvis lying between them. The backward curve of the bodies of the sacral vertebræ and the straightness and shortness of the anterior wall of the pelvis render the excavation much more roomy in an

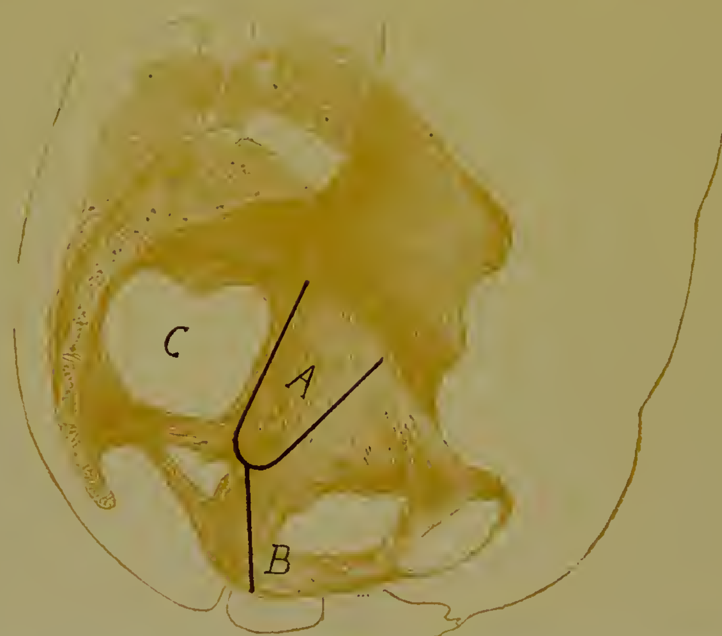


FIG. 217.—Diagram showing a division of the lateral wall of the excavation into sections in accordance with their mechanical functions.

antero-posterior direction than is either of the straits, and this increase of space is, of course, greatest in the middle portion of the excavation. The oblique diameters are correspondingly increased for the same reason, and, indeed, in the middle of the excavation they are often longer than any of the diameters of a small fetal head—a fact which is sometimes of importance in the mechanism of posterior positions of the vertex and of presentations of the face.

If the transverse diameters of the excavation were similarly ample, this portion of the pelvis would be devoid of obstetrical interest; but this is far from true. The transverse diameter of the excavation is at one point the smallest and also one of the most rigid diameters of the whole pelvis, and the importance of the anatomy of the lateral walls of the excavation is so great that its comprehension is the key-note to the whole subject of obstetrical mechanism. The anatomy of the lateral walls is so difficult of description that it is possible to comprehend it only by means of a subdivision of the lateral walls of the excavation into three parts (Fig. 217): An *upper portion* (*A*, Fig. 217), which is roughly triangular in shape; a *second portion* (*B*), which lies below and in front of the first; and a *third portion* (*C*), which lies below and behind the first.

Portion A is composed throughout of unyielding bone. In its upper part its surface is smooth and very uniformly curved. The transverse diameter of the pelvis at this point is the ample transverse diameter of the superior strait. The oblique lines drawn through the anterior edge of this portion upon one side of the pelvis and through the posterior edge of the corresponding portion upon the other side are likewise ample, and, indeed, vary but little from this same length (5¼ inches). In its lower part portion *A* of the lateral wall inclines inward to its termination in the rigid ischial spines, between the points of which the smallest diameter of the pelvis is found—a diameter so small as to be practically impassable by the biparietal and suboccipito-bregmatic diameters of a full-sized head.

Portion B of the lateral walls of the excavation has but little rigid bone in its composition. Its upper part is made up mainly of the membranous coverings of the foramen ovale, that are covered by the obturator muscle, and at the time of term, like all the other ligaments and fascial coverings of the pelvis, are more elastic than in the non-parturient state. When these muscles and fasciæ are put upon the stretch by the pressure of the presenting part during its descent, their recession converts portion *B* of the lateral wall into a shallow spiral groove, with bony edges and a soft floor, which deepens as it descends and turns forward. The ischio-pubic ramus, which forms the floor of the lower part of portion *B*, is here so curved (laterally outward) as to lend itself readily to the continuation of this groove.

Portion C has a bony edge composed of the posterior border of the ischium and the lateral edge of the sacrum and coccyx, but it is made up mainly of the very elastic sacro-sciatic ligaments and the pyramidal muscle. When these ligaments and muscles are put upon the stretch during the descent of the head, portion *C* of the lateral wall is converted, like portion *B*, into a spiral groove which deepens as it descends and turns forward.

When the rigidity of portion *A* and the yielding nature of portions *B* and *C* are considered in connection with the fact that even in the bony pelvis the foramen ovale and the sacro-sciatic notches are regions of recession separated from each other by the projecting ischial spines, it will be seen that when distended by pressure from within, the lateral walls of the excavation may be considered as consisting, for mechanical purposes, of two deep grooves separated from each other by a prominent ridge of unyielding bone (Fig. 218). The anterior of these grooves pursues a spiral course downward and forward from the anterior end of the oblique diameter at the brim, to end under the pubic arch at the anterior end of the conjugate diameter of the inferior strait. The posterior groove pursues a similar spiral course downward and forward from the posterior end of the other oblique diameter at the brim, to end in the same point at the anterior end of the conjugate at the outlet.

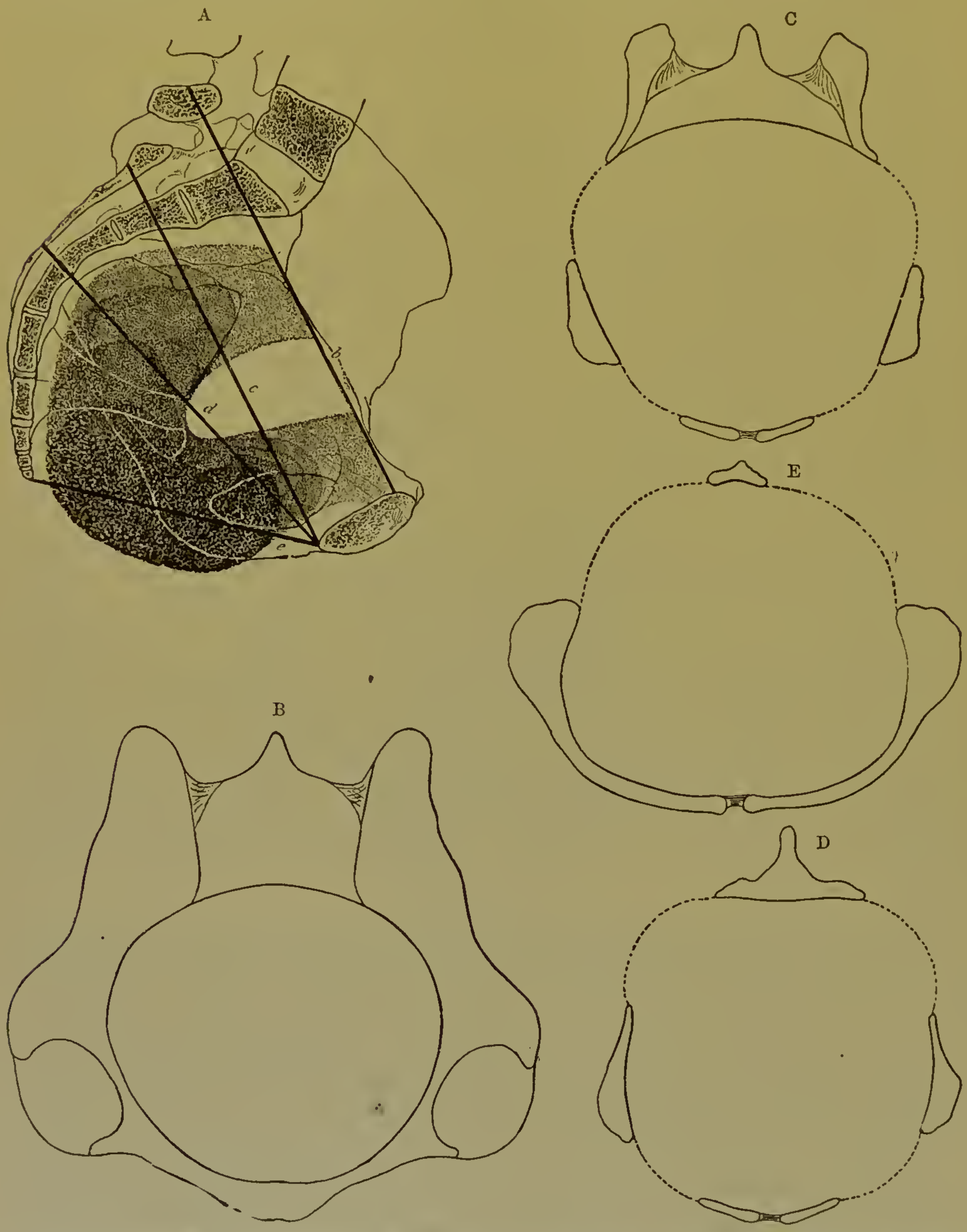


FIG. 218.—Sections of the pelvis, showing the lateral grooves and the bony ridge which separates them: A, sagittal section. The lines *b*, *c*, *d*, *e*, indicate the horizontal planes through which the cross-sections *b*, *c*, *d*, *e*, are taken. The shaded portions of the figure indicate the spiral grooves, the depth of the groove being deepest where the shading is darkest. B, cross-section, showing the nearly-uniform curve of the unbroken bony circumference of the superior strait. C, cross-section, showing the bony ischium (A, Fig. 217) separating the distensible foramen ovale (B, Fig. 217) and sacro-sciatic notch (C, Fig. 217). D, cross-section through the ischial spines, which here emphasize deflection inward of the bony ridge (A, Fig. 217). E, cross-section near the inferior strait. The posterior half is distensible, and in the anterior half the bony descending ramus of the pubes curves outwardly to continue the curve formed by the yielding tissues which cover in the foramen ovale, as seen in the sections C and D.

The oblique diameters drawn toward the bottom of the anterior groove upon one side and the bottom of the posterior groove upon the other side are throughout the pelvis ample for the passage of any of the diameters of the fetal head except the occipito-frontal and the occipito-mental. Should any round body be started at the upper end of either of these grooves, and be forced downward by a *vis-a-tergo* under the influence of a constant intrapelvic pressure, it must necessarily follow the path of least resistance—that is, the course of the groove in which it started—to end its course under the pubic arch at the outlet. The importance of these considerations will be apparent when the section on the *Mechanism of the Second Stage of Labor* is reached.

Infrapelvic Portion.—When the soft parts below the inferior strait are distended by the head, they include a hood-shaped space of considerable size, bounded upon its upper border by the edge of the pubic arch, the tuberosities of the ischia, and the lower edge of the sacro-sciatic ligaments, and upon its other or inferior border by the orifice of the distended vagina. Its anterior wall is from a quarter to half an inch in length. Its posterior wall, when fully distended, is from 6 to 10 centimeters ($2\frac{1}{2}$ to 4 inches) in length.

When the head has wholly escaped from the inferior strait it occupies an elastic canal composed wholly of soft parts and having but one mechanical function—an elasticity which keeps the head constantly in contact with the edge of the pubic arch.

The Parturient Canal as a Whole.—The parturient canal (Fig. 211) consists functionally of two portions, an ovate reservoir formed by the uterine cavity and the false pelvis, and a curved passage which extends downward and forward from the lower opening of the reservoir. This passage possesses an irregularly cylindrical shape which has classically been likened to the curve of a ram's horn. The anterior wall is much shorter than the posterior. If both the anterior and posterior walls are divided into an equal number of equal parts, and planes are drawn between each pair of these points (Fig. 219), a curved line passing through the centre of each of these planes forms what is known as the *axis of the pelvic canal;* if this curved line is continued forward, it will reach the abdomen of the mother at about the situation of the umbilicus in the non-parturient state. This prolongation of the pelvic axis is known as the *curve of Carus.*

The centre of any body passing through the pelvic canal must travel through a path closely approximate to this curved axis. Were the pelvic canal exactly cylindrical and the fetal head exactly spherical, the mechanism of labor would be limited to an observation of the above-related fact; but in reality the irregularities in the contour of the pelvic canal and the corresponding irregularities in the shape of the fetal head are matters of the greatest importance. It will be remembered that although the transverse diameter of the superior strait is nominally the greatest, yet the rapid convergence of the ilio-pectineal lines as they stretch forward renders the length of the practicable transverse diameter in fact less than that of the oblique diameters, so that any ovate body presented to the inlet of the pelvis will tend to enter the brim in the oblique diameter.

At the inferior strait the transverse diameter is the narrowest of the whole pelvis, and, since the oblique diameters at the moment of delivery are shorter than the distended conjugate, any ovate body which attempts to pass the outlet will do so most readily if its long diameter corresponds with the antero-posterior diameter of the inferior strait. It is therefore evident that the process of

FIG. 219.—Sagittal section of the pelvis, showing the pelvic axis and the curve of Carus.

labor will most easily be accomplished by the occurrence of a rotation of the longest diameter of the presenting parts from an oblique position at the superior strait to an antero-posterior position at the outlet; in point of fact, the mechanical relations which lead up to this rotation lie at the bottom of the whole subject of the mechanism of labor.

It is to be noted that when the woman is in the erect position the axis of the superior strait * forms an angle of about 30° with the horizon; that in the same position of the woman the axis of the inferior strait is directed downward and a little forward; and that the axis of the vaginal outlet of the parturient canal looks almost directly forward and but very slightly downward.

Differences between the Male and the Female Pelvis.—It is important that the obstetrician should clearly understand the normal characteristics of the female pelvis in contradistinction to those of the masculine form, because the approaches to a masculine type—which are not uncommon and may occur in any portion of the pelvis—are not unimportant as a cause of dystocia and

* A line drawn from the centre of the superior strait in a direction perpendicular to its plane.

of alterations in the mechanism of labor. The differences between the male and the female pelvis will be rendered most easily familiar by the use of a series of figures showing respectively the shapes of the superior strait, of the

FIG. 220.—Male pelvis viewed in the axis of the brim.

antero-posterior curve of the sacrum and the pubic arch, and of the inferior strait in the masculine and feminine types.

Superior Strait.—In the male the sacrum is narrow, the promontory encroaches deeply into the brim, the iliac crests are comparatively erect, and the interior concavity of the anterior portion of the ilio-pectineal line is but little

FIG. 221.—Female pelvis viewed in the axis of the brim.

marked (Fig. 220). The shape of the inlet is thus angular and strongly cordate as compared with that of the female pelvis (Fig. 221).

Antero-posterior Section of the Pelvis.—In the male the sacrum is long and its upper portion is nearly straight, while the lower part of this bone and its continuation, the coccyx, are bent sharply forward. The symphysis and the adjacent portions of the descending rami are long and erect (Fig. 224). In the

FIG. 222.—Male pelvis seen from the front.

female (Fig. 225) the sacrum is shorter, its general direction is more distinctly downward and backward, its upper portion is much more concave from above downward, and the antero-posterior curve is throughout more uniform than in

FIG. 223.—Female pelvis seen from the front (one-third natural size).

the male. The symphysis is short, and the wider pubic arch, shortly to be spoken of, decreases the importance of the descending rami in the formation of the anterior wall.

Inferior Strait.—In the male (Fig. 222) the angle of the pubic arch measures from 75° to 80°. The anterior wall of the pelvis—that is, the distance between the symphysis and the tuberosities—is long as compared with the pelvis of the female (Fig. 223), in which pelvis the sides of the pubic arch form an angle of from 90° to 100°, and the entire depth of the pelvis is much diminished. The backward recession of the tip of the sacrum and the coccyx, together with the increased distance between the tuberosities, greatly

FIG. 224.—Diagrammatic antero-posterior section of male pelvis.

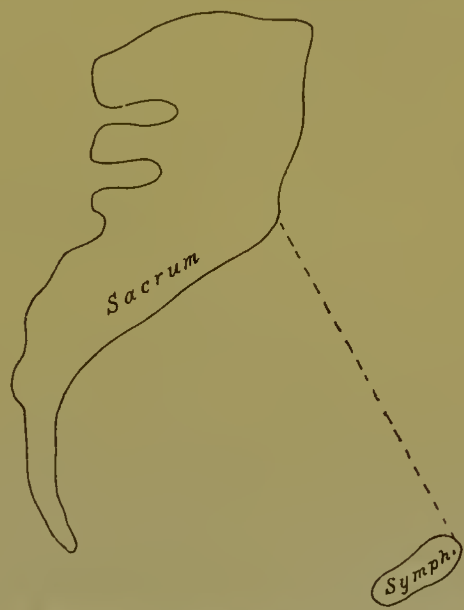


FIG. 225.—Diagrammatic antero-posterior section of female pelvis.

increases the size of the inferior strait in the female (Fig. 221) as compared with the male (Fig. 220). There is a greater relative distance between the acetabula, and their surfaces are directed somewhat obliquely to the front. This situation of the acetabula is decidedly unfavorable to the function of the hip-joints in locomotion, and it accounts for the greater proximity of the knees in women and for the characteristic difference between their gait and that of men, whose pelvic bones are designed for locomotion alone.

THE FETUS.

The head of the new-born child is, proportionately to its body, so much larger than that of the adult, and the body is proportionately so much the more compressible, that the head is in most cases the only part of the body that affords any considerable mechanical obstacle to the passage of the fetus through the parturient canal. From its comparative incompressibility it is, moreover, the part which most nearly retains its normal shape throughout labor, and it is therefore in the passage of the head that the mechanical processes of labor are most plainly marked and most important.

From the foregoing considerations it is at once apparent that a thorough familiarity with the dimensions and shape of the fetal head and with the changes it undergoes during labor is a necessary preliminary to the comprehension of the principles of obstetric mechanism. Some familiarity with the shape and dimensions of the remainder of the fetus in the attitude it ordinarily assumes, though less often of importance, is nevertheless essential.

The Fetal Head.—The head is obstetrically divided into two portions, the *face* and the *cranium*.

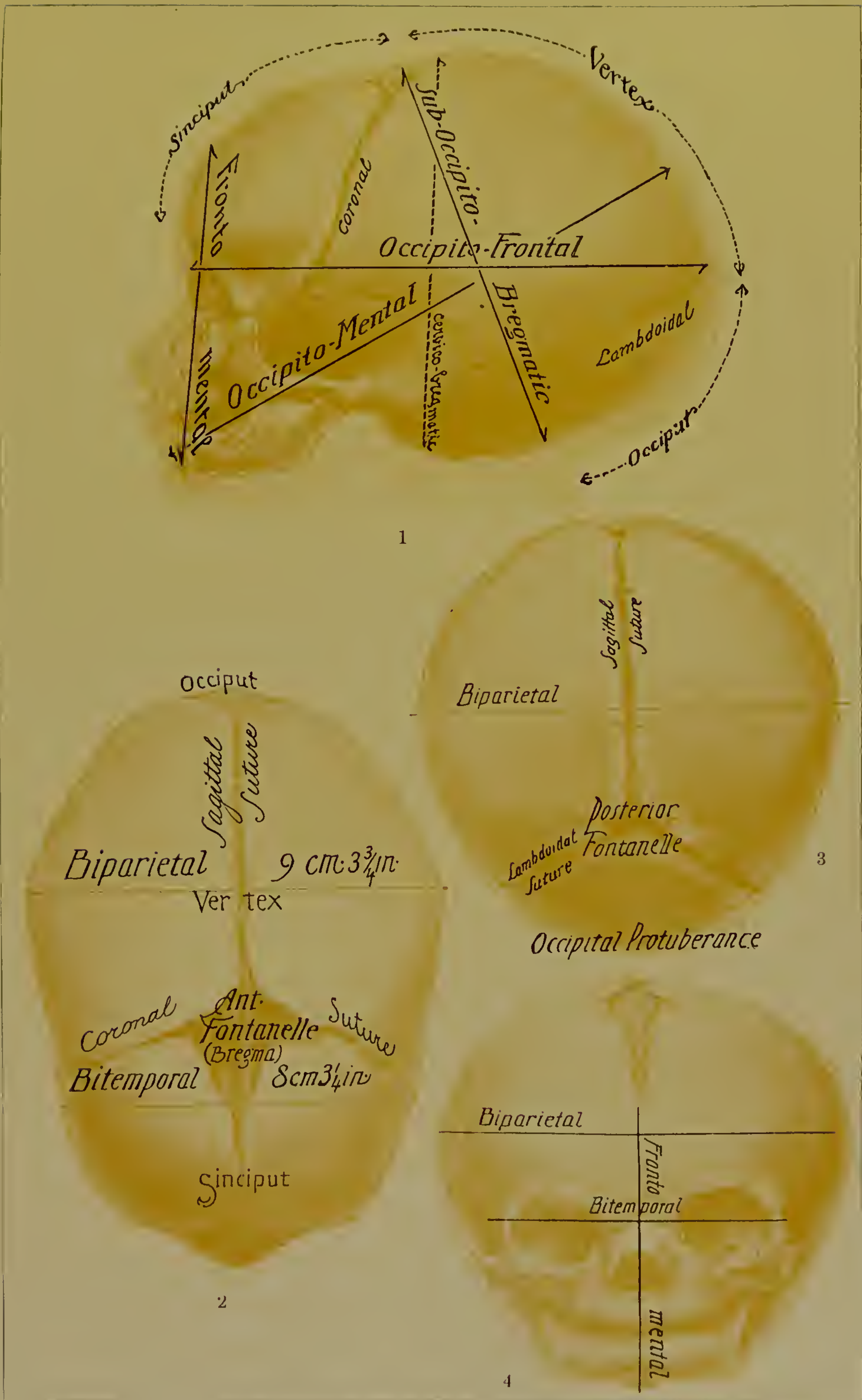
The face is much smaller in proportion to the cranium than that of the adult, and is of but little importance in normal labors. It is, however, well to remember that the face is made up of the most solid and incompressible bones which enter into the composition of the head, and that its configuration is altered but little, if at all, by the processes of labor.

The cranium or *brain-case* is to be divided for purposes of description into two portions, the *base* and the *vault* of the skull. The base is formed by the basilar portion of the occipital bone, the petrous portions of the temporal bones, the sphenoid and ethmoid, and the orbital processes of the frontal bones. These bones, even at birth, are firmly united, and they form a comparatively small but almost totally incompressible mass. The vault is made up of the parietal bones and the squamous portions of the occipital, temporal, and frontal bones. These bones are all wide, flat, and slightly curved. The squamous portion of the occipital bone is attached to the basilar portion by a band of fibro-cartilaginous tissue which permits of quite free motion between the two portions. All the bones of the vault are united at their edges by membranous commissures formed of the dura mater and the unossified external periosteum. The vault of the cranium, though much larger than the base of the skull, differs from the base in its possession of compressibility and of a marked capacity for alteration of shape under the moulding influences of the constant pressure of labor. It must be remembered, however, that different heads present very different degrees of ossification at the time of birth, and, indeed, vary widely, from cases in which the flat bones are so slightly ossified as readily to be bent by the pressure of the finger, and in which the membranous intervals are extremely wide and well marked, up to cases in which the ossification and union of the bones are so far advanced as to reduce the compressibility of the skull to a minimum of small practical value.

Fig. 226.—Diagrams of the fontanelles: A, anterior; B, posterior; C, lateral.

The Sutures and the Fontanelles.—The membranous lines of union between the contiguous bones of the vault are known as *sutures*, and at the points where more than two bones meet these sutures commonly widen out to membranous spaces known as *fontanelles* (Fig. 226). The sutures are distinguished by the following names: That between the frontal bones is the *frontal;* that between the frontal and parietal bones is the *coronal;* that between the parietals is the *sagittal;* and that which separates the squamous portions of the occipital from the two parietals is the *lambdoidal* suture.

At the point where the frontal and parietal bones come together the frontal,



FETAL HEAD: 1. Fetal skull seen from the side; 2. Fetal skull seen from above; 3. Fetal skull seen from behind. 4. Fetal skull seen from in front—showing sutures, fontanelles, and diameters.

sagittal, and coronal sutures meet in a membranous space or fontanelle which is rhomboidal in shape and is ordinarily of considerable extent. This space is known as the *anterior* or large fontanelle, and sometimes as the *bregma* (Pl. 28, Fig. 2). Of its four sides, the two anterior are usually the longer, and when this difference is well marked the resulting fontanelle may more properly be said to assume the shape of an Indian arrow-head (Fig. 226, A).

The junction of the sagittal and lambdoidal sutures at the point where the occipital and parietal bones meet forms a small triangular space, known as the *posterior* occipital, or small fontanelle (Pl. 28, Fig. 3). In well-ossified heads this space is frequently small or wanting, and the posterior fontanelle is then represented only by the junction of the three sutures. It is to be remembered, moreover, that when the bones are closely crowded together by the pressure of severe labor, either fontanelle, however well marked, may partially or wholly be effaced for the time by an overlapping of the edges of the bones which bound it. Exceptionally, a locally defective ossification along the edges of the bones may result in the production of either Wormian bones or false fontanelles, both of which are most common in the course of the sagittal suture, and which may result in considerable confusion of diagnosis if the possibility of their existence is not borne in mind.*

Dimensions of the Fetal Head.—The size of the fetal head at term varies greatly with the size of the individual fetus, but, however great this variation may be, the relative proportions between the different parts of the head remain approximately constant, and for the sake of clearness it is usual, in the discussion of general principles, to ignore this variation of size and to use as the basis of argument the dimensions of the average head. The diameters that have been found most useful in the description of the head are as follows: The *antero-posterior diameters*—the occipito-mental, the occipito-frontal, the suboccipito-bregmatic; the *transverse diameters*—the biparietal, the bitemporal, and the bimastoid; the *vertical diameters*—the fronto-mental and the cervico-bregmatic.

Antero-posterior Diameters.—The occipito-mental diameter (Pl. 28, Fig. 1) is drawn from the chin to the most distant portion of the occiput. The occipito-frontal (Pl. 28, Fig. 1) is drawn from the point of union of the supraorbital ridges to that portion of the occiput which is most distant from them. The suboccipito-bregmatic (Pl. 28, Fig. 1) is drawn from the point of junction between the occiput and the neck to the centre of the anterior fontanelle.

Transverse Diameters.—The biparietal diameter (Pl. 28, Figs. 2, 4) is drawn from the apices of the biparietal protuberances—namely, through that portion

* It is well to bear in mind, in addition to the anterior and posterior fontanelles, the occasional existence of a third, the *lateral* fontanelle. This fontanelle is present only in poorly-ossified heads, and when present is found at the junction of the occipital, parietal, and temporal bones, near the base of the mastoid process and behind the ear. The lateral fontanelle may sometimes be mistaken for the bregma unless carefully observed. It is four-sided, but is irregular in shape (Pl. 28, Fig. 2). It may be said that the mastoid process feels like the side of a large canine tooth imbedded in the temporal bone. It is usually recognizable, and it is sometimes a valuable point in the diagnosis of this region of the skull.

of the skull at which the lateral surfaces are most widely distant from each other; the bitemporal (Pl. 28, Figs. 2, 4) extends transversely between the most distant portions of the coronal sutures; the bimastoid extends between the mastoid processes at the base of the skull. To these diameters is sometimes added a less important diameter, which is that lying between the base of the zygomatic processes, the bizygomatic.

Vertical Diameters.—The fronto-mental diameter (Pl. 28, Figs. 1, 4) extends from the chin to the upper part of the forehead; in the absence of any distinctive point of origin at its upper extremity, as well as from its small size, it is of but little importance. The cervico-bregmatic (Pl. 28, Fig. 1) is drawn between the junction of the neck and the chin and the centre of the anterior fontanelle.

The lengths of the several diameters, as obtained by Tarnier and Chantreuil, are given as follows:

	Centimeters.		Inches.
Occipito-mental diameter	13	=	5¼
Occipito-frontal "	11.5	=	4½
Suboccipito-bregmatic diameter	9.5	=	3¾
Biparietal diameter	9.5	=	3¾
Bitemporal diameter	8	=	3¼
Bimastoid diameter	7.5	=	3
Fronto-mental diameter	8	=	3½
Cervico-bregmatic diameter	9.5	=	3¾

These diameters may be divided into classes in two ways: (1) by their compressibility, and (2) by the degree of difficulty with which they may be expected to pass the pelvis. The compressibility of the fetal head as a whole is not only a very variable factor, but the different parts of the same head vary widely in both the ease and the safety with which compression can be applied to them.

The biparietal and bitemporal diameters are safely and easily compressible. The suboccipito-bregmatic, occipito-frontal, and occipito-mental diameters are almost equally compressible, but the degree of danger to the fetus that compression of these diameters involves is vastly greater than is the case with the biparietal and bitemporal diameters; and with oblique compression the degree of danger increases as the direction of the force approaches to the antero-posterior diameters. The bimastoid and bizygomatic diameters are for practical purposes totally incompressible.

The Relative Value of the Diameters of the Head as Compared with the Diameters of the Pelvis.—It will be observed that the lengths of the suboccipito-bregmatic and biparietal diameters are nearly equal, so that a cross-section of the head through these diameters (Fig. 227, A) is very nearly circular; and from this fact and from their size this cross-section is capable of passing any diameter of the pelvis when presented to it in any obstetrical position. Since this is the cross-section which is always presented to the pelvis by well-flexed heads, the study of position would be of little importance if the existence of flexion could always be depended upon and if the remainder of the head could be neglected; but two factors in labor equally contribute to render this cross-section of the head by no means the only one which must be considered. In the first place, we must be prepared to consider the mechanism of brow and face cases, and, in addition, those cases of vertex labor in which the flexion of the head is, from one cause or another, imperfect; and, moreover, even in the best vertex labor good flexion is seldom attained in the early stages

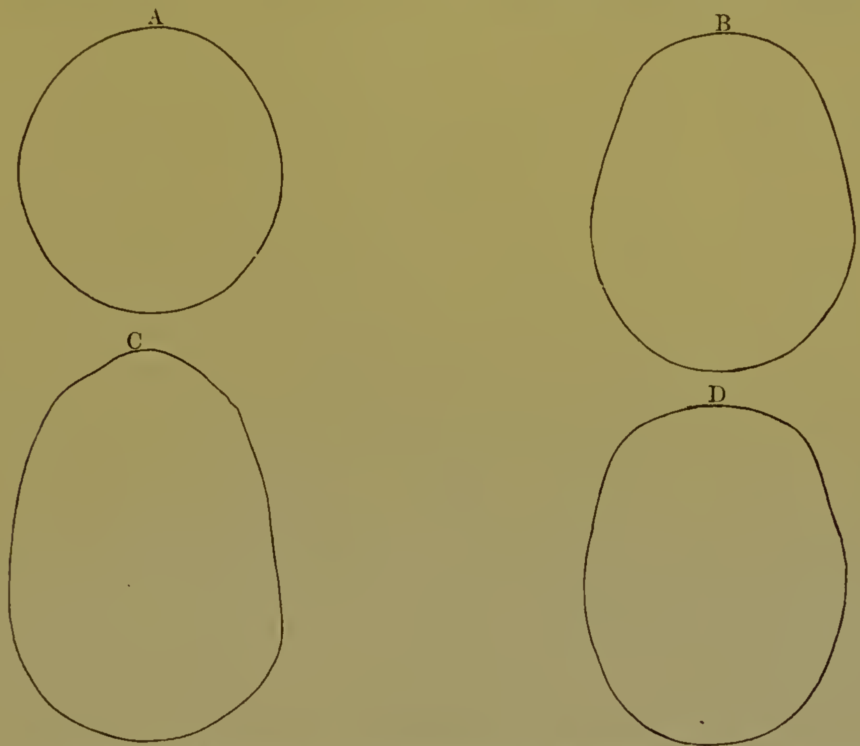


FIG. 227.—Diameters of the fetal head: A, cross-section of the fetal head through the suboccipito-bregmatic and biparietal diameters; B, cross-section of the fetal head through the biparietal and occipito-frontal diameters; C, cross-section of the fetal head through the biparietal and occipito-mental diameters; D, cross-section of the fetal head through the suboccipito-frontal and bitemporal diameters.

of engagement at the brim. Secondly, even when good flexion is present and this circular cross-section is in the inferior strait or excavation, the brim is occupied by the frontal portion of the head in combination with the neck—a by no means unimportant factor in the mechanism of even the most normal cases.

It is therefore important to remember the shape and dimensions of the cross-sections, which include, first, the biparietal and occipito-frontal diameters (Fig. 227, B); second, the biparietal and occipito-mental diameters (Fig. 227, C); third, that which cuts the head and neck through what might be called the "suboccipito-frontal" diameter* and the bitemporal diameter (Fig. 227, D). If the diameters of these cross-sections be compared with those of the pelvis, it will be seen that all the transverse diameters are capable of an easy passage through any of the diameters of the pelvis. The occipito-frontal and sub-occipito-frontal are too large to pass any of the conventional † diameters except the oblique diameters at the superior strait and the distensible antero-posterior

* Approximately the cervico-bregmatic plus the thickness of the neck.
† Those which have names.

diameters of the inferior strait; while the occipito-mental is too large even for these, and may consequently be regarded as an impracticable or impossible diameter.

A careful remembrance of the relative values of these diameters will be found of great service in the comprehension of normal labor, and of still more value in understanding abnormal labor.

The Articulations between the Head and the Spinal Column.—The articulations by which the head is joined to the trunk are, it will be remembered, the occipito-atlantoid, the atlanto-axial, and those between the other cervical vertebræ. The occipito-atlantoid articulation admits of but little motion except that of extension and flexion, while even that motion, when carried to extremes, is greatly assisted by a similar movement in the other cervical articulations. So, too, the rotatory movement which alone is possible in the atlanto-axial joint is greatly assisted by the movements in the other articulations of the neck. The capacity for lateral flexion resides wholly in the intervertebral articulations and is limited by their ligaments. Rotation of the head to either side is safely possible only through an arc of about 90°; that is, when the chin of the fetus is in the plane of the shoulders the limit of safety in rotation has been reached. Antero-posterior flexion is limited only by contact between the chin and the breast. Extension can be carried to a point at which the occiput rests against the back of the neck and the chin is in a line with its anterior surface.

The Fetal Body.—The compressibility of the fetal trunk renders impossible and worthless any statement of the absolute length of the diameters which the fetal body presents to the pelvis during labor; but the relative lengths of the transverse and antero-posterior diameters as compared with each other is of importance, and is constant in at least two parts of the trunk—namely, in the regions of the shoulders and the hips. The transverse diameter in both these regions is always longer than the antero-posterior diameter.

The Shoulders.—The relation of the shoulders of the infant to the mechanism of labor is somewhat altered by their movability. The shoulders may be presented to any portion of the pelvis in one of two positions: First, they may enter together, with the line of the clavicles approximately at right angles to the spine—that is, in the position ordinarily assumed by adults. Second, one shoulder may be elevated and the other depressed, so that the one enters in advance of the other, both clavicles being still approximately in the same line, but this line now forming an oblique angle with that of the vertebral column. In the second, which is the usual and normal position, the transverse diameter never loses its superiority of length over the antero-posterior diameter. When both shoulders enter together, this superiority of the transverse diameter is always somewhat less marked, and is occasionally so much diminished as to lead to interruptions of the mechanism by which the delivery of the shoulders is normally accomplished.

The Hips.—The pelvic bones of the infant are sufficiently rigid to prevent any considerable moulding of the breech, and the transverse diameter of the hips is always considerably greater than the antero-posterior diameter of the same portion of the body.

The Trunk.—The intermediate portions of the infant's trunk are so soft and compressible that its diameters are totally inconstant. The shape of the cross-section of the trunk corresponds with the shape of that portion of the pelvis in which it lies, and even the presence of the limbs in juxtaposition with it makes but little difference, since its softness permits the limbs, under the pressure of labor, to indent it at any point.

Diagnosis, Frequency, and Prognosis of the Several Varieties of Labor.

Diagnosis.*—In obstetric diagnosis we are furnished with two methods of examination of almost equal importance—namely, examination of the abdomen and examination of the vagina—which must be described separately.

The abdominal examination must be subdivided into inspection, palpation, and auscultation. In the use of this method of examination it is best for the beginner to ignore the possibility of O. L. P. and O. D. A., on account of their great infrequency and of the excessive complications that an effort at their recognition would involve.

The value which the individual obstetrician places upon an abdominal examination is generally proportionate to the experience he has enjoyed. The beginner should be urged to avail himself of every opportunity for practising this method, for, while he will find in his early practice many cases in which the obesity of the patient or the rigidity of the abdominal muscles and uterus renders abdominal palpation of no value, a large number in which the examination is inconclusive, and only a few in which he can attain a clear diagnosis by this means, yet as his experience enlarges the first class will steadily decrease in number and the latter two will increase proportionately, if he is faithful in practising palpation upon every case that comes under his charge; and the value which attaches to facility in making a diagnosis by this means in many difficult operative cases can be appreciated only by those who possess it. It is certainly a fact that to the experienced hand abdominal palpation yields results fully as valuable as those which can be obtained by digital examination per vaginam, and that there are but few cases in which repeated examinations during the progress of labor will fail to establish a diagnosis by palpation and auscultation alone.

Abdominal Inspection.—Inspection is mainly valuable as affording a hint of the existence of transverse presentations and of multiple pregnancy.

Abdominal Palpation.—Palpation is the most important part of the abdominal examination; it should be performed only in the intervals between the pains, all pressure of the hand being intermitted with the appearance of

* Although the methods which must be used in making the diagnosis of presentation and position are indicated in another part of this work, such a diagnosis is so essential to the mechanical management of labor that it seems wise to repeat the technique of the several methods of examination in this section.

each contraction. The physician should stand by the patient's side facing toward her head, and should apply the palm of each hand flat against the corresponding side of the uterus. Throughout the examination it is all-important that the motions of the hand should be slow and gentle, any quick or jerky impulse being almost certain to result in rigidity of the abdominal walls and the uterus, thus frustrating the purpose of the examination. Every effort should be made to divert the attention of the patient, to soothe her fears, and to assure her that the examination will not be painful. It not infrequently happens that the first attempt will be a total failure, while the second will yield satisfactory results owing to the changed mental condition of the patient.

Diagnosis of Presentation by Palpation.—The finger-tips of each hand should be pressed with a gradual and gentle motion downward behind the symphysis pubis in search of the fetal head (Fig. 228), which in cephalic presentations is almost always to be felt in this situation as a marked transverse check to the examining hand. In this examination care should be taken to note on which side the head is most plainly perceived, since with a well-flexed head the frontal extremity is much the more easily reached, with the partially extended head but little difference is to be noticed, and in face presentations the occiput is much the more distinct.

FIG. 228.—Diagnosis of presentation by palpation.

The fundus should then be palpated carefully as a further means of excluding the possibility of a breech presentation. The head may be distinguished from the breech at the fundus by its greater size and mobility, by its rounded contour as opposed to the tapering form of the smaller breech, and by an easily distinguished sulcus which corresponds with the neck of the child; but the best evidence of the presence of the breech at the fundus is always the recognition of a head presentation by deep palpation behind the symphysis.

Differential Diagnosis of Presentations by Palpation.—Cephalic Presentations.—The most distinctive sign of head presentations is to be found in the recognition of the head by deep palpation behind the symphysis. The diagnosis should then be checked by ascertaining the absence of the signs characteristic of the head at the fundus.

Pelvic Presentations.—In breech presentations the obstetrician's attention is generally first arrested by the absence of the transverse check to the fingers, due to the presence of the head, on deep palpation behind the symphysis. He should then be able to recognize the presence of the head at the fundus by the signs just enumerated.

Transverse Presentations.—In transverse presentations the long axis of the child is felt to be transverse. The differential diagnosis between the head and the breech is always of importance, and is to be made by the signs enumerated above as characteristic of the head.

Diagnosis of Position by Palpation.—The hands should be placed along the sides of the uterus and should make gentle but deep pressure toward each other (Fig. 229)—that is, with the uterus and child directly between their

FIG. 229.—Diagnosis of position by palpation.

palms—in the effort to estimate the relative resistance afforded by the right and left sides of the uterus, the flat, firm back of the child usually presenting a resistance to pressure that is markedly greater than that of the yielding abdomen and the movable limbs.

The differing resistances having been estimated, the fingers should be applied to the sides of the uterus, not with the tips deeply indented into the abdomen, but with their whole palmar surface pressed firmly against the uterus; the hands should then be moved gently up and down along the uterine wall in an endeavor to recognize the irregularities due to the presence of the fetal limbs. During this search it is necessary to guard against the error of mistaking either of the round ligaments for the fetal members. These ligaments, which at term are of nearly the size of the adult finger, extend obliquely from the cornua of the uterus downward, outward, and forward to the pelvic brim. They may be recognized by their situation and by the pain of which the patient invariably complains when they are rolled about under the fingers. The existence of small subperitoneal fibroids is another possible source of error. With thin and flaccid abdominal walls it is sometimes possible by this method to recognize the fetal limbs with the utmost distinctness, but in the majority of cases an irregularity in the contour of the fetus is all that can be hoped for.

By palpation, then, we can hope to distinguish not only the presentation, but also the position, since the latter must correspond with the quarter of the pelvis in which the fetal back is found. Owing to the infrequency of O. D. A. and O. L. P. positions, it is generally safe to call all cases in which the back of the child is found toward the left, O. L. A., and those in which it is found toward the right of the mother, O. D. P.

Abdominal Auscultation.—Auscultation of the fetal heart gives confirmatory evidence about the presentation and position, informs us of the condition of the child, and is the most important sign in the recognition of multiple pregnancy.

In vertex presentations the heart is most plainly heard over the back of the child and below the mother's umbilicus;* in breech presentations the heart is heard over the back, but its greatest intensity is generally above the mother's umbilicus; while in presentations of the face it is most readily heard over that portion of the uterus which corresponds with the chest of the child, but is again below the umbilicus. In transverse presentations the heart is usually plainly audible when the back is anterior, but is often found with difficulty in the posterior varieties, and is of comparatively little value in the diagnosis of position.

In interpreting the evidence of position furnished by the situation of the fetal heart it must not be forgotten that, owing to the fact that sound is better conducted by solids than by liquids, the exact situation of the fetal heart-sounds corresponds with that portion of the back or chest which happens at the moment to be in contact with the uterine wall; the situation of the fetal heart-sound, therefore, may vary temporarily with the position of the mother, as one or the other shoulder rests against her soft parts, or it may temporarily be absent (especially when the patient lies upon her back), owing to the intervention of the liquor amnii between the fetal chest and the physician's ear.

* Owing to the oblique position which the shoulders normally occupy, the dividing-line between the right and the left position of the heart-sounds in this and in all longitudinal presentations should be that drawn between the umbilicus and the right anterior superior spine of the ilium rather than the median line of the body.

In addition to the value of auscultation in the diagnosis of position, its importance in the recognition of the condition of the fetus can hardly be overestimated, any fatigue of importance being quickly shown by alteration of the rate and regularity of the heart-sounds. In addition to the fetal heart-sounds, the so-called "uterine" or "placental souffle" is generally heard as a soft blowing sound synchronous with the mother's pulse; this sound is of no practical value.

Summary of Diagnostic Signs furnished by the Abdominal Examination.—At the conclusion of the abdominal examination its results should be summed up and a diagnosis be made by some such mental process as the following:

The first process of palpation, described on page 409, enables one to determine whether the presentation is cephalic, pelvic, or transverse, and this result is checked by the position of the fetal heart as obtained by auscultation; that is, in cephalic presentations the heart is found below the umbilicus, in breech presentations above it, and in transverse presentations a little toward that side of the abdomen to which the head is directed.

The position is determined by the situation of the fetal back, as established by the second method of palpation, described on page 409, and by the position of the fetal heart, which position should correspond with that of the fetal back.*

If the presentation is either breech or transverse, no further determination is necessary, or indeed possible, by the abdominal examination; but if the presentation is cephalic, it is both necessary and possible to determine whether it is a presentation of the vertex, the brow, or the face. In vertex presentations the end of the head that corresponds with the fetal abdomen—that is, the face—is found at a higher level than the opposite or occipital end, and the fetal heart is heard over the back. In face presentations the end of the child's head that corresponds with the abdomen—that is, the face—is palpated less readily than the dorsal (occipital) end of the head, and the heart is heard over the front of the child.†

In brow presentations both ends of the head are easily reached by palpation. The heart is usually heard over the back.

Vaginal Examination.—*Technique of the Examination.*—In obstetric work it is usually best to avail one's self of the extra length of the middle finger by employing two fingers for all examinations, except in those cases in which the extremely narrow vulva of a primipara makes the introduction of the second finger painful to the patient. Most American obstetricians prefer to

* Except in face presentations (see p. 459).

† It will be perceived that the distinction between vertex and face presentations by abdominal examination is likely to be difficult, since in a left anterior position of either presentation the most accessible end of the head will be found in the right posterior quarter, while in both presentations the heart is left anterior; the only distinction is to be found in the position of the fetal limbs as compared with the heart, and in the perception of the greater size and more rounded contour of the occiput as opposed to the face; but the great infrequency of face presentations and the ease with which they are distinguished on vaginal examination make this source of error a matter of small importance.

examine the patient when in the left lateral decubitus, but it is well to accustom one's self to examining in all positions, not only in the interest of the patient's comfort and convenience, but also because it is often possible by changing the decubitus to reach a portion of the child that has before been unattainable.

The vulva being aseptic, the hand, having been thoroughly disinfected and anointed with an aseptic lubricant, should be introduced under the bed-clothes, which should be so held up by the other hand as to protect them from contact with the examining fingers; these should be placed against the genital cleft, and be swept gently forward until they find the entrance of the vulva and come in contact with the fourchette, friction against the vestibule and clitoris being carefully avoided in the process.

As the examining finger enters the vagina it should note successively the size of the vulvar orifice, the position of the coccyx, the shape of the sacrum,* and the condition of the rectum—whether full or empty. These points having been ascertained, the finger should be passed upward into the posterior fornix, and be swept forward over the soft and yielding vault of the vagina in the effort to find the external os, which is usually situated in the median line and near the centre of the pelvis. In case of failure to find the os readily, the field of the pelvis should be quartered systematically by the examining finger, much after the fashion employed by a pointer dog in searching a field for game. If the cervix be not yet taken up, it is recognized as a rounded prominence, on the summit of which is found the orifice of the os if the patient be a primipara; in multiparæ the lacerated and ragged condition of the cervix frequently makes the external os indistinguishable from an early stage of labor, but the finger in such cases may usually be passed into the cervical canal, and will then recognize the presence of the internal os. If the cervix has been wholly taken up, the os is best recognized by passing the finger through it and into the space between the cervix and the presenting part.†

The physician's ability to reach the upper portions of the pelvis is more dependent upon the position in which his hand is held than upon the length of his fingers. When he desires to reach the upper and posterior parts of the pelvis, his hand should be held in the position indicated in Figure 230, the perineum being strongly retracted by the pressure of the web between the second and third fingers. When the object sought for lies nearer the anterior wall of the pelvis, the position of the hand should be altered by rotation of the forearm into the position represented in Figure 231. The upper border of the second finger is now pressed firmly against the edge of the pubic arch, and the pulp of the finger is directed anteriorly.

* The writer strongly recommends the practice of roughly measuring the conjugate diameter by reaching upward for the promontory of the sacrum, as a routine measure, at the conclusion of the first examination in each case, and he believes that many operative difficulties may be avoided by this simple procedure.

† Unless this precaution of hooking the finger about the edge of the os be observed, the beginner is liable to mistake a fold of the vaginal wall, or in breech presentations the anus, for the os uteri, both of which mistakes have been made by medical students in the presence of the writer.

The os having been reached, the finger should note its size, the thickness of its edge, and its consistency, whether hard or soft, and by very gentle stretching should endeavor to ascertain its degree of dilatability; in this last maneuvre it is necessary to employ the greatest gentleness in order to avoid the inex-

FIG. 230.—Positon of the hand in digital examination of the fetus along the posterior wall of the pelvis.

cusable accident of a manual laceration of the os during examination. The characteristically different sensations yielded to the finger by the smooth and velvety cervix, the rough but slippery membranes, and the hairy scalp is a matter with which it is important to become familiar, for it is easy to recognize

FIG. 231.—Position of the hand in digital examination of the fetus along the anterior wall of the pelvis.

these differences if the physician has trained himself to observe them in even a comparatively small number of cases, and the possession of this faculty may at some time preserve him from the dangerous or even fatal error of making an application of the forceps to the intact membranes or over an undilated cervix.

If the cervix is thin, it may be possible to recognize the presenting part through its substance; but in ordinary cases it is necessary to introduce the finger through the os in order to distinguish between the different parts of the child. The finger should be passed up until it comes in contact with the presenting part, and it should then seek systematically for marks by which the character of this part can be determined. The presence of the head is to be determined by the perception of one or more sutures; that of the face, by the presence of the mouth and nose;* that of the breech, by the recognition of the spinous processes of the sacrum, the genitals, and the anus. The tuberosities of the ischia and the pubic arch are also easily recognizable. The shoulder presents no very distinctive marks, and the diagnosis of a transverse presentation is not easily made by vaginal examination during the early stages of labor unless a hand and an arm are prolapsed, but it should always have been recognized by abdominal palpation before the vaginal examination is made. The various distinctive marks of each of the presentations must be sought for, and the diagnosis is to be made in accordance with those found to be present.

Summary of Signs of each Presentation.—The diagnosis of presentation by vaginal examination, though ordinarily easy, is sometimes difficult when the presenting part is still high in the pelvis. It would be supposed, *a priori*, that the distinction between the hard head and the yielding breech could be made in all cases with the greatest ease, but a considerable experience in the superintendence of students has convinced the writer that this point of consistency is a most unsafe and unsatisfactory guide, and some personal experiences have led him to adopt the rule of never permitting himself to diagnose a head unless it is possible to recognize at least one suture, nor to commit himself to the diagnosis of a breech without inserting the examining finger into the anus and recognizing the presence of the coccyx.

Vertex Presentations.—In vertex presentations the finger should first recognize the convergence of the lambdoidal and sagittal sutures forming the small fontanelle. The finger should then pass along the sagittal suture until it reaches the large fontanelle and recognizes the four sutures which enter it. It should next search for the ears, the mastoid processes, and the lateral fontanelles, all of which may usually be found by following the lambdoidal sutures to their terminations. The ear is always recognizable, the mastoid and the lateral fontanelles are less constantly conspicuous, and all these marks are usually less easily reached upon the posterior than upon the anterior side. The ear, when reached, always points toward the occipital end of the head, unless, as sometimes happens, it is folded forward against the scalp—a fact which is easily recognized if the finger is passed backward and forward a few times across the ear. With a well-flexed head the posterior fontanelle is lower in the pelvis than is the bregma, and the upper and posterior part of the ear is generally the more easily accessible. When the head is somewhat extended the fontanelles are upon about the same level in the pelvis, and the anterior edge of the ear is most easily reached. With extreme extension of a vertex presentation the

* Care must be taken not to mistake the supraorbital ridges of a face presentation for the suboccipital ridges of a well-flexed vertex presentation.

eyebrows are not infrequently accessible (see *Brow Presentations*). The diagnosis of position in vertex presentations is made by ascertaining the position of the occiput; this is obtained, first, by comparing the positions of the small and large fontanelles in the pelvis, and, second, by observing the direction in which the flaps of the ears point.

Brow Presentations.—When the extension is so extreme that the small fontanelle is reached with difficulty and the supraorbital ridges and the bridge of the nose are well below the brim of the pelvis, the presentation is that of a brow. By very high examination the mouth can occasionally be touched in brow presentations. The position is named after the position of the small fontanelle, but care should be taken to check the diagnosis by an independent observation of the root of the nose, which should, of course, be in the opposite quarter of the pelvis.

Face Presentations.—When the supraorbital ridges are found upon one side of the pelvis and the point of the chin upon the other, the presentation is a face. Before the diagnosis is considered assured the fingers should recognize, in addition to the chin and the supraorbital ridges, the mouth, the nostrils, the eyes, and the root of the nose in their proper positions; and it is even well to adopt the precaution of always inserting the finger into the mouth and ascertaining the presence of the maxillary processes and the tongue, which can be mistaken for nothing else. The position is indicated by the position of the chin, and should be checked by an observation of the position of the frontal suture.

Breech Presentations.—In breech presentations we must distinguish, during the vaginal examination, between presentations of the whole breech and footling presentations. In presentations of the whole breech the finger should recognize the spinous processes of the sacrum, the anus, and the genital cleft. In boys the scrotum often becomes enormously distended, and this may lead to confusion if the possibility of the fact is not borne in mind. When a breech presentation is found, the finger should always be inserted into the anus, and be made to recognize the tip of the coccyx, the tuberosities of the ischium, and the pubic arch. The position is named, as has been said, after the position of the sacrum, and it is most easily determined by finding the position of the tip of the coccyx of the fetus by rectal examination. In footling presentations one or both ankles or feet protrude through the os.

Presentation of a Hand or a Foot.—If the membranes be ruptured, a presenting hand or a foot may easily be drawn outside the vulva and be recognized by the eye; if this be impossible, it may easily be differentiated by the touch through the membranes by observation of the following points: The foot is to be distinguished from the hand by the presence of the malleoli and of the prominence of the heel, and by the facts that the great toe is of equal or greater length than the others and is placed in the same plane with them; while the hand is recognized by the absence of the heel, by the fact that it can be placed in direct continuation of the line of the limb to which it is attached, and that the thumb is shorter than the fingers and can be opposed to them. The importance of avoiding rupture of the membranes in such presentations is, however, so great that it is usually best to trust to the results of external palpation.

Presentations of the Knee and the Elbow.—The knee may sometimes be distinguished from the elbow by the presence of the patella; but, since the latter is small and not always easy of recognition, it is best to distinguish between these two joints by following the course of the limb to its termination in a hand or a foot as the case may be.

Transverse Presentations.—The shoulder is liable to be mistaken only for the breech, from which it may be distinguished by the presence of but one limb in place of the two which are attached to the pelvis, and by recognition of the smooth ridge of the scapula as opposed to the rough spines of the sacrum; recognition of the clavicle and the ribs will also assist the diagnosis; but the recognition of a shoulder by vaginal examination is extremely difficult, and the existence of the presentation is practically ascertained, in the majority of cases, by external palpation, without assistance from vaginal examination.

In presentations of the hand it is sometimes possible to make a diagnosis of position by observation of the hand alone; to this end it is first necessary to determine which hand of the fetus presents, this being best ascertained by attempting to shake hands with the presenting part, the right hand of the fetus coming into position to shake hands with the right hand of the physician, and the left with the left. If the presenting hand be turned by rotation of the forearm into forced supination, the thumb points to the side on which lies the fetal head, and the back of the hand corresponds with the back of the fetus; but in actual practice the attitude of the child so seldom corresponds exactly to any one of the four classical positions that this evidence is of comparatively slight value, and is only to be used as confirmatory of the results of palpation.

FREQUENCY.—The vertex presents in about 97 per cent. of all labors, the breech presents in about 2 per cent., and the remaining 1 per cent. is made up of brow, face, and transverse presentations, the latter two being the more frequent.

PROGNOSIS.—*Vertex Presentations.*—In vertex presentations the prognosis for both mother and child is better than in any other variety of labor. It varies, however, to some slight degree with the position, being better in anterior than in posterior positions, on account of the somewhat longer and more difficult labors which are to be expected, as will be seen, in the latter.

Face Presentations.—In face presentations the prognosis, though not necessarily bad, is always worse for both mother and child than in vertex cases; for, although the majority of face labors are terminated with safety and rapidity by the efforts of nature, yet in the comparatively small number of cases in which an arrest occurs, and in which art must step in, the delivery is often extremely difficult. The prognosis for the mother is that of the operation indicated, but in the operative delivery of face cases the dangers to the fetus are always peculiarly great.

Brow Presentations.—In brow presentations the prognosis for both patients is that of the operation by which the case is delivered. It is therefore necessarily worse than that of vertex presentations.

Breech Presentations.—In breech presentations the prognosis for the mother is only altered from the normal by the fact that the rapid extraction of the after-coming head and arms that is very frequently necessary is attended by a greatly increased liability to perineal and cervical lacerations. The prognosis for the child is always bad, especially among primiparæ or with women who for any other reason have rigid soft parts.

Transverse Presentations.—Transverse presentations must always be terminated by art, and the prognosis varies with the period of labor at which interference is undertaken. In uncomplicated transverse presentations an early version is usually easy, and the prognosis for both patients is therefore good. In neglected cases the operation is always difficult, and the prognosis for both patients is bad.

1. Vertex Presentations.

Frequency of Cephalic Presentations.—At the end of pregnancy the cephalic end of the child presents in about 97 per cent. of all cases. In 97,871 births in private practice Spiegelberg found head presentations in over 97 per cent. In 23,000 cases confined in Guy's Hospital Lying-in Charity the percentage of head presentations was 96.9. Premature delivery and stillbirth of the fetus decrease greatly the proportion of head presentations. Thus, Collins found that head presentations occurred in 97 per cent. of living children among about 16,000 deliveries at term, and in only about 80 per cent. among 500 births of putrid fetuses. Churchill found that at seven months only 83 per cent. of living and 53 per cent. of dead children are born by cephalic presentation. DuBois found 83 to be the percentage for living children and 45 for dead children at the same period.

It is found that during the latter months of pregnancy changes in the presenting pole of the fetus occur once or more in from 35 to 40 per cent. of all cases. The change from a pelvic or a transverse presentation to a cephalic, however, is very much commoner than the loss of a cephalic presentation. The latter would therefore seem to be the position of more stable equilibrium, and it will be found that these observations—namely, the decreased percentage of head presentations among premature and stillborn children, and the greater stability of head presentation as compared with any other—have an important bearing upon the etiology of the presentations.

Relative Frequency of the Four Positions.—In about 75 per cent. of all cephalic presentations the occiput is found upon the left side of the mother, and in more than 73 per cent. of this 75 per cent. the position is anterior—that is, O. L. A. In the remaining 25 per cent. the occiput is of course directed to the right side of the mother, but the determination of the relative frequency of right anterior and right posterior positions is not so easily determined, there being great differences of opinion upon this point among different observers, the key to this difference of opinion being probably found in their adoption of different periods of labor for the determination of the position.

In a large proportion of those cases in which the occiput is to the right and somewhat anterior at the very beginning of labor—that is, before the head is even pressed into the superior strait—the position becomes right posterior as soon as engagement occurs. It is probable that some observers have classified such cases as O. D. A., and others as O. D. P. Again, the enormous majority of right posterior positions become right anterior by rotation during the second stage of labor. An observer who made his diagnosis only during the latter part of the second stage would class all such cases as anterior positions. It is certainly a fact that the vast majority of right positions are right posterior positions at the time when the greatest diameter of the head occupies the superior strait; and if this period of labor be selected as the time when the position should be determined, it is safe to say that nearly 75 per cent. of all cases are primarily O. L. A., and almost 20 per cent. are primarily O. D. P. Of the small remainder, almost 4 per cent. are primarily O. D. A., and but a little over 1 per cent. are O. L. P.

Etiology of Presentations.—Three conditions have been urged as chiefly contributing to the frequency of cephalic presentations, and it seems probable that the true cause must be found in a combination of all three conditions, which probably vary in their importance in individual cases. These three causes are—first, the effect of gravity; second, the easier adaptation of the fetus to the uterine cavity in head presentations; and third, the effect of active movements on the part of the fetus.

In estimating the relative importance of these factors in the etiology of head presentations, it is evident that to attain the truth it is necessary to reach a conclusion which will explain the results of clinical observation recorded above, and which will make evident not only the reasons for the great preponderance of cephalic presentations of the fetus, but also for its variability in accordance with the period of delivery and the condition of the fetus.

The Influence of Gravity.—It has been found by experiment that if a recently-dead fetus at term be immersed in a saline fluid of the specific gravity of the liquor amnii, it tends, under the influence of gravity, to assume an oblique position, with the head lower than the breech and the right side lower than the left. This fact is explained by Matthews Duncan, who has shown that the specific gravity of the fetal head is greater than that of the decapitated trunk, and that the greater specific gravity of the right side is due to the enormous relative size of the liver in the new-born child. It is evident, then, other conditions being equal, that we may expect, in a preponderance of cases, to find the head and right shoulder of the fetus in that portion of the uterus which is horizontally lowest in the ordinary positions of the mother.

The ordinary positions of the mother may be considered in this connection to be three—the vertical position of the trunk, the horizontal position in a dorsal decubitus, and the horizontal position in a lateral decubitus. When the trunk is erect the anterior uterine wall is inclined to the horizon at an angle of about 35°, and the lowest portion of the uterine cavity is to be found in the neighborhood of the pubes. Most pregnant women are in this position—that is, either standing or sitting—for about two-thirds of the twenty-four hours, and it is consequently the most important of the three positions in this connection. In this position of the mother the child would tend to assume, under the influence of gravity, precisely the position in which it is usually found—that is, a vertex presentation, O. L. A.—and in the absence of disturbing elements it will be in this relation to the mother about two-thirds of the time.

When the woman lies upon her back the posterior uterine wall is inclined to the horizon at an angle of about 55°, and the lowest portion of the uterus is in the neighborhood of the promontory. Thus, in this position also the influence of gravity tends to maintain a cephalic presentation.*

When the woman lies upon her side the lowest point of the uterine cavity is usually near the fundus and toward the side upon which she reclines.† In this position, then, the influence of gravity would be exerted against the maintenance of a cephalic presentation; and since the lateral decubitus is maintained by most pregnant women for the greater part of that third of their time which is spent in bed, it is evident that the influence of gravity would not, by itself, be a sufficient cause for the appearance of a cephalic presentation in so large a number as ninety-seven out of every one hundred labors; but since, from the influence of gravity alone, it is probable that the head would maintain, other influences being excluded, a cephalic presentation during the greater part of the time, it is fair to assume that this furnishes a predisposition toward the existence of a cephalic presentation in any given case. When, moreover, we investigate the relation of this factor to the variation in percentages due to premature births and stillbirths, we find its influence so entirely in accord with the results of clinical observation as to add still further proof of its importance. Thus, Dr. Duncan found that when a child dies *in utero* before labor, the specific gravity of its head is less than that of a living child, and the body, when uncontrolled, often actually floats head uppermost in a saline fluid. Again, it is highly probable that the relative difference between the specific gravity of the head and that of the body is less among premature than among full-term children, since we know that the proportionate development of the brain and the cranial bones, in comparison with that of the body, is much less during the early months of pregnancy than it becomes at term.

It may with propriety be conceded that the greater specific gravity of the cephalic pole of the fetus is a predisposing cause of head presentations, and it only remains to be determined whether the other causes are sufficient to maintain this position when once established.

* Though with the back of the fetus toward the back of the mother (see *Etiology of Position*, p. 422).

† When the woman lies upon her right side the influence of gravity tends to turn the back of the child forward, and when she lies upon her left side tends to turn it backward.

Adaptation between Fetus and Uterus.—It is usual to consider the uterus as a flaccid mass which readily moulds itself to the shape of its contents or its surroundings; but when we remember that during each contraction the uterus straightens itself and tends to assume a definite form, and that, moreover, there is undoubtedly a process of slight rhythmic contraction going on throughout the whole of the latter part of pregnancy, it is evident that the uterus must be regarded as a body which has, to some extent at least, a definite, intrinsic shape. It has, moreover, been determined by post-mortem examinations that this shape is one which alters, and alters in a definite direction, during the development of the uterus.

At and for some time before the fifth month the uterine cavity is nearly spherical (Fig. 232), and is very large as compared with the still small and undeveloped fetus; but from this time on the cavity becomes progressively

FIG. 232.—Relative size of the fetus and the uterine cavity at the fifth month.

FIG. 233.—Adaptation between the uterus and the fetus at term in vertex presentation.

more and more pyriform, until toward the end of pregnancy it assumes the definitely pyriform shape shown in Figure 233. The uterine cavity, at term and under normal conditions, is but little larger than the fetus.

It is, moreover, evident, on comparing the shape of the fetus in its ordinary attitude with the shape of the uterus at term, that in head presentations (Fig. 233) the fetus and the uterus are extremely well adapted to each other, but that in breech (Fig. 234) or in transverse presentations one portion of the uterine muscle is subjected to an undue amount of tension, while other portions are unduly relaxed; therefore any change from the cephalic to either a breech or a transverse presentation will be opposed by the contractile power of that portion of the uterine muscle that would be overstretched in the new presentations; that is, we may assume that the shape and contractility of the uterine walls tend to preserve a cephalic presentation when this is once well established, and that the rhythmical contractions would probably tend to re-establish it when lost. It is safe to assume, then, that the shape of the uterus may be considered an important factor in preserving a cephalic presentation when this has once been established by the influence of gravity, and that its insensible contractions furnish an influence of importance in re-establishing a head presentation when this has been lost.

Influence of the Fetal Movements.—Since the fetal movements are accidental and independent of any volitional impulse, it is probable that their occurrence would be insufficient to effect any considerable change in the relation of the fetus to the uterus unless in an extremely relaxed condition of the uterine and abdominal walls, and that even in such uteri the change would be likely to occur only when the position of the mother added the influence of gravity to the effect of fetal movements. It is evident that even in such cases the operation of the same causes would probably tend to a speedy assumption of the cephalic presentation.

FIG. 234.—Adaptation between the fetus and the uterus at term in breech presentation.

Conclusions.—It is now necessary to consider how far the conditions just enumerated explain the observed facts quoted at the beginning of this section: *First,* that cephalic presentations preponderate in the proportion of 97 to 3; *second,* that this preponderance is much decreased by both premature deliveries and stillbirths; *third,* that the change from a pelvic or a transverse presentation into a cephalic is very much more common than the loss of a cephalic presentation; and *fourth,* that both abnormal presentations and changes of presentation are much commoner among multiparæ and when the quantity of liquor amnii is large.

First.—The existence of a condition, the influence of gravity, that tends to establish a cephalic presentation, and that is operative for two-thirds of the time, in combination with other conditions which render any other presentation unstable, and which are operative all the time, is, in the absence of anything which favors any other presentation, sufficient to account for almost any percentage of preponderance of cephalic presentations.

Second and Third.—In the middle of pregnancy the shape of the uterine cavity is nearly spherical and its size is greatest as compared with that of the fetus; the latter is but little developed and the presentations are totally uncertain. During the sixth and seventh months the conditions approach nearer to those observed at term; but even in the eighth and ninth months the difference in the specific gravity of the cephalic and pelvic ends of the infant is less marked than at term; the pyriform shape of the uterus is less strongly marked, and the adaptation between the uterus and the fetus is less close; that is, all the factors which we have been considering as important in the production of the preponderance of cephalic presentations have less value than at term. We find by observation that at these periods the preponderance of cephalic presentations is correspondingly decreased, and that spontaneous changes of presentation are correspondingly much more frequent than at the end of pregnancy; we are, then, justified in our belief in the importance of these factors.

Fourth.—These considerations are in full accord with the observed fact that both abnormal presentations and changes of presentation occur most frequently in multiparæ with relaxed uterine and abdominal walls, and are but rarely seen in the more rigid condition of the muscles that is characteristic of first pregnancies. So, too, it is fully established that these changes and abnormal presentations occur much more frequently when the quantity of liquor amnii is relatively so great that the uterus tends through distention to acquire a more nearly spherical shape, and when the limbs of the fetus are accorded much greater freedom of movement.

As a result, it seems safe to assume that the influence of the relatively greater specific gravity of the cephalic pole of the fetus is the predisposing cause, and that this, together with the intrinsic shape of the uterine cavity and the influence of the movements of the fetus, are the maintaining causes of the great preponderance of cephalic presentations.

Etiology of Position.—It has already been observed (p. 419) that in the erect posture of the trunk, usually assumed by the woman for two-thirds of the twenty-four hours, the influence of gravity tends to the production of an O. L. A. position, and in the remaining one-third of the twenty-four hours the influence of gravity varies with the decubitus which the woman assumes in bed. Therefore it may safely be assumed that any conservative factors which appear late and tend to fix the child in any position in which they find it are more likely to find it O. L. A. than in any other position. Such a factor is to be found in the shape of the superior strait. The presence of the rectum in the left ilio-sacral notch renders the second oblique diameter of the pelvis less ample than the first, so that if the oblique cross-section of the head that is ordinarily presented to the pelvis at the inlet rests with its long diameter in correspondence with the second oblique diameter at the brim, the head is less easily accommodated than if it is presented to the first oblique diameter. It will, then, as the adaptation becomes progressively tighter and tighter, tend to remain in the first oblique diameter for longer periods than in the second; that is, it will be dislodged with difficulty from the first oblique diameter, and with ease from the second by any slight cause; and since the influence of gravity tends during the greater part of the time to turn the occiput forward, a head which occupies either an O. D. A. or an O. L. P. position will tend to become O. L. A. rather than anything else. The maintenance of an O. D. P. position is, moreover, rendered comparatively unlikely from the fact that the shape of the head is less well adapted to that of the pelvis in this position. Changes of position are, in fact, extremely frequent until within the last few weeks before delivery, and the position, moreover, is never finally determined until the head engages at the brim.

Diagnosis.—On *abdominal examination* the head is found at the inlet; the fetal limbs and the most accessible end of the head are found on one side of the abdomen, and the heart on the other. On *vaginal examination* the finger should recognize the small fontanelle on one side of the pelvis, and by following the sagittal suture should find the large fontanelle on the other. The ears should always, and the mastoids and lateral fontanelles should usually, be felt at the ends of the lambdoidal sutures.

Prognosis.—The prognosis for both mother and child is better than in any other variety of labor.

A. Mechanism of the First Stage of Labor.

It is customary to divide labor into three stages. The first stage comprises the time occupied in the dilatation of the os; the second, that expended in the descent and expulsion of the child; while the third is occupied by the birth of the placenta.

For purposes of description it is well to consider the three stages as being sharply divided from one another, but it must be remembered that clinically the division between the first and second stages is often difficult and indefinite, since the final stages of dilatation are not infrequently accomplished only during the descent of the head; and for clinical purposes it is well to define the end of the first stage as occurring whenever the os is fully dilated or dilatable, it being understood that the expression "fully dilatable" refers to a condition in which the os, though still imperfectly dilated, has become so soft and elastic as not to offer any efficient obstacle to the descent of the presenting part.

To understand exactly the mechanism of labor it is necessary to discuss first the forces by which the process is accomplished, and next the manner in which each force acts during the different stages of labor.

The forces by which labor is effected are those produced by the contraction of the uterine and abdominal muscles, together with such influence as can be effected by the weight of the child and the waters.

The uterine muscle acts in two ways: first, by diminishing the intra-uterine area and thus creating a general intra-uterine fluid-pressure due to the contraction of the uterus upon the fluid contents of the unruptured ovum; second, by the force of direct contact between the breech and the fundus of the uterus whenever a rupture of the membranes and the consequent escape of the waters permit this contact to occur. Direct contact may also occasionally occur, as will be seen later, before the rupture of the membranes.

The abdominal muscles when set into voluntary contraction reinforce both forms of action of the uterine muscle. When the uterine muscle is in direct contact with the breech, the abdominal muscles, lying in close contact with the uterus, add their force to that which the uterus itself exerts against the child; when the child is protected from contact with the uterine walls by the presence of a quantity of liquor amnii, the contraction of the abdominal muscles again adds itself to that of the uterine wall, and thus adds its increment to the general intra-uterine fluid-pressure. The force of gravity is inactive in many positions of the mother, and is at most an increment of but small importance.

In considering the manner in which the above-mentioned forces are employed in effecting the dilatation of the os during the first stage of labor, it is necessary to consider several variations which may occur in the mechanical conditions. When the waters are abundant and the membranes persist unbroken throughout the first stage, the dilatation is usually accomplished by the action of the membranes only. This may be considered the normal mechanism of dilatation, and must be described first, after which it will be proper to take up the various conditions in which, from one cause or another, the membranes cease to act their proper part, and the dilatation must be accomplished by the pressure of the fetal head against the cervix.

Normal Mechanism of Dilatation.—In the first instance—that is, when the waters are abundant and the membranes are intact—the position of the fetus is unaffected by the intra-uterine fluid-pressure. It is an axiom in physics that fluid-pressures, however produced, are invariably equal and opposite in all directions, from which it follows that, the pressures *A* (Fig. 235) being equal and opposite to the pressures *B*, the child will be unmoved by the uterine contraction. Similarly, the fluid-pressure upon any one portion of the uterine wall being equal to that exerted upon any other portion of equal area, there would be no effect, even upon the shape of the uterus, if its entire surface contracted at once and if its walls were of uniform strength throughout. The initial stages of dilatation of the os are in reality to be referred to the fact that the lower uterine segment possesses less muscular strength than the upper part of the uterus, and to the character of the uterine contractions. Neglecting for the moment the latter factor, and limiting the discussion to the effect of the different strengths of the upper and lower uterine segments, we shall see that the contraction of the more powerful upper part of the uterus forces the less powerful lower portion open, notwithstanding its efforts at contraction.

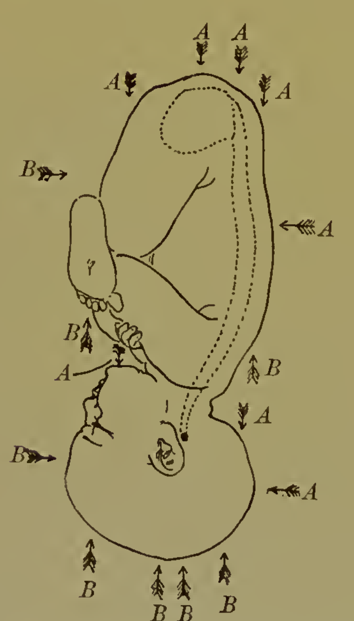


FIG. 235.—Diagram illustrating the absence of alteration in the attitude of a child by the action of opposite and equal fluid-pressures.

The total force exerted by the uterine contractions results in the application of a uniform centrifugal pressure upon all portions of the containing wall. The amount of this pressure upon any given unit of surface—as, for example, a square inch—will, of necessity, be equal to the average force exerted by the same superficial extent of the uterine wall; hence it follows that at any portion of the viscus where the strength of the wall is greater than the average the contracting centripetal force will tend to overcome the resulting centrifugal force, and the result will be a decrease in the extent of the uterine walls at that point. Similarly, at any point where the strength of the uterine wall is below the average the expanding centrifugal force of the fluid-pressure will be greater than the centripetal force of the contracting muscles, and at such points, therefore, the expanding force of the fluid-pressure will tend to overcome the contracting force of the uterine muscles, and there will be a consequent increase in the area of those portions of the uterine wall. Now, the lower uterine segment is by all odds weaker than any other portion of the uterus; it therefore tends to expand during the contraction from the action of the general intra-uterine fluid-pressure.

The circular portion of the uterine area, which is opposite to the lumen of the vagina, is, moreover, unsupported by the general intra-abdominal pressure and by the force of the tonicity of the abdominal muscles that is exerted upon all the other portions of the uterus—a fact which, by deereasing the centripetal force, still further increases the surplus of the centrifugal element at this point. As a matter of fact, at the beginning of labor the first influence of the uterine contractions is seen in the assumption by the lower uterine segment of a more expanded shape, such as shown by the dotted outline in Figure 236. Moreover, since at one point in the lower uterine segment the cohesion of its substance is still further lessened by the existence of a solution of continuity, the lumen of the os uteri, it is evident that there will be a still more marked tendency to expansion at this weakest spot, resulting in a tendency to dilatation of the os.

FIG. 236.—Diagrams showing the diminution of the upper uterine segment and the expansion of the lower segment during each contraction.

To these considerations must be added the effeet of the peculiar composition of the uterine muscle and of the peculiar character of its contractions. It is essential to remember that this highly composite muscle is made up of interlacing fibres, whose action may mechanically be divided into one set of longitudinal and one of circular stresses; that is, if the action of those fibres having an oblique direction be resolved, as is physically allowable and proper, into their longitudinal and transverse resultants, the action of the whole will be found precisely equal to that which would be exerted by two hypothetical sets of fibres, of which the first and most powerful set directly encircle the uterus in horizontal zones, while the second and less powerful set extend upward through the margin of the os, cross the fundus, and thence passing down to reach the margins of the os at points opposite to their origins.

If a uterine muscle so composed were set into action, it will be seen that, from a mechanical standpoint, the circular fibres surrounding the os would by their contraction tend to keep it closed, while the longitudinal fibres, acting in opposition to these, would by their contraction tend to open the os by drawing its margins apart over the contained ovum. This conception, though somewhat more simple than the actual anatomical fact, is mechanically essentially correct; but, since the circular stresses are the more powerful, it is evident that this arrangement cannot result in the dilatation of the os unless complicated by the presence of some additional factor. This factor is found in the circumstance that the contractions of the uterine muscles, like those of all the hollow viscera of the body, are peristaltic, and that the rhythmic contraction of the uterus begins at the fundus and passes gradually down to the cervix. Each contraction of a given part of the uterus is preceded and followed by a relaxation; but since, from the interlaced arrangement of the fibres of the uterus, the contraction of any portion of its surface necessarily exerts a longitudinal strain, it will be found that the outward stress upon the margins of the os remains nearly constant, while its circular contraction is intermittent; it is probable that the initial dilatation of the os is largely due to the constancy of the longitudinal and the intermittency of the circular strain; that is, the first gains in dilatation are made at moments when the uterine muscles of the lower uterine segment and the cervix are relaxed, but when the general fluid-pressure is maintained by contractions of the upper portions of the uterus.

As the internal os and the upper portion of the cervix dilate under the action of these forces, a new mechanism comes into play through the elasticity of the membranes, which bulge through the circle of the os and enable the intra-uterine fluid-pressure to take direct effect upon its margins. As this process continues the internal os becomes effaced, the cervix is shortened and

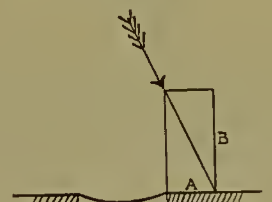


FIG. 237.—Diagram illustrating the dilatation of the os by the membranes. If the application of the fluid-pressure to the os (at right angles to the surface of the membranes at this point) is represented by the direction of the arrow, and the amount of the force by the length of the diagonal line which continues the arrow, the amount of force that is applicable to the dilatation of the os is represented by the length of the line A.

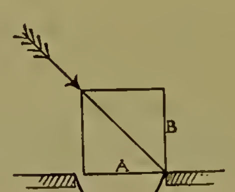


FIG. 238.—Diagram illustrating the dilatation of the os by the membranes. All the conditions are identical with those of Figure 237, except that the membranes have a greater convexity; the direction of the arrow is therefore more oblique, and the force efficient for dilatation, represented by the line A, is greatly increased.

disappears, and finally the external os itself is in direct contact with the membranes and begins to receive directly the effect of the longitudinal stresses. As the external os dilates the membranes again bulge forward into its lumen, and the force of the fluid-pressure becomes directly active upon its margins. The force so exerted is directly proportional to the convexity of the membranes, and increases as the convexity increases—a fact which is explainable by well-known physical laws as follows: The force of fluid-pressure, in addition to being opposite and equal at all points, is always exerted at right angles to any surface against which it is applied. If it is necessary to ascertain what portion of the force is exerted in any given direction, it is only necessary to break up the internal force into its elements by the construction of a parallelogram of forces, such as is described in all elementary treatises on mechanics and illustrated in Figures 237 and 238. Figure 237 exhibits the influence of the general intra-uterine fluid-pressure when the conditions of the case allow but a slight convexity to the unsupported portions of the membranes. The expansive element of the fluid-pressure is here represented by the line A, while in Figure 238, where the convexity of the unsupported membranes is much greater, the expansive element of the force will be represented by the length of the much longer line A: from this it follows that, other things being equal, the rapidity of dilatation will be proportional to the degree to which the membranes project through the os. As will be seen later, the same considerations are equally applicable to the action of the head in producing dilatation after the rupture of the membranes. The familiar clinical fact that the closing stages of dilatation are usually much more rapid than the beginning stages is fully explained by the foregoing considerations, taken in connection with the equally familiar fact that the contractions of the uterus tend normally to become stronger and stronger throughout the process of labor.

In the more normal form of the mechanism of the first stage—that is, so long as the membranes remain intact—the progress of the first stage of labor is dependent mainly upon the first form of force which the uterine muscle is capable of exerting—that is, the force of the general intra-uterine fluid-pressure—and the membranes are the dilating agent.

The second form of force, that of the direct pressure of the uterine muscle against the child, is under these circumstances inoperative, while the fact that the voluntary muscles of the abdominal walls are but seldom brought into play by the patient reduces the action of the remaining or auxiliary forces, in this form of the mechanism of the first stage, to the small reinforcement of the general intra-uterine fluid-pressure, which is due to the general intra-abdominal pressure constantly exerted by the tonicity of these muscles.

Mechanism of Dilatation of the Os after Rupture of the Membranes, with Partial or Complete Escape of the Waters.—*Partial Escape.*—After the rupture of the membranes the liquor amnii tends to drain away until its escape is stopped by the contact of the presenting part with the margins of the os (Fig. 239). In this condition the presenting part forms with the circle of the os a ball-valve; the general intra-uterine pressure is concentrated upon its upper surface, and its descent is opposed only by the comparatively feeble resistance of the cervix. When this condition occurs the portions of the fetus that correspond with arrows marked *A′* and *B′* are still affected by pressures which are opposite and exactly equal to the propelling force exerted upon the portions which correspond with the arrows *A* and *B*, but the propelling force represented by the arrow *C* is opposed only by the resistance of the unsupported cervical and vaginal tissues, against which the head is pressed by a force equal to the effect of the intra-uterine fluid-pressure upon an area

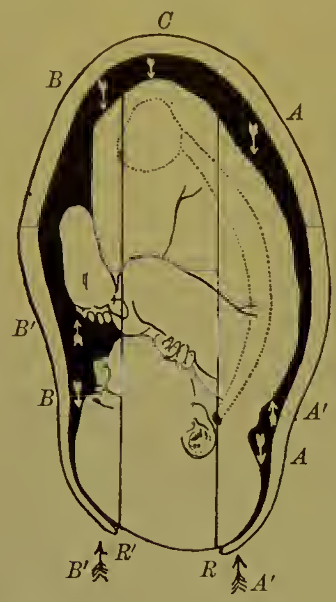


FIG. 239.—Diagram illustrating the manner in which the general intra-uterine fluid-pressure becomes propulsive after the rupture of the membranes.

FIG. 240.—Diagram illustrating the dilatation of the os by the head. The total force is again represented by the oblique line, and the force which is applicable for dilatation is represented by the line *A*.

equal to the transverse area of that zone of the uterus where the head first comes in contact with the walls—that is, the surface *R* to *R'*.

FIG. 241.—Diagram illustrating the dilatation of the os by the head. The total force is represented by the oblique line, and the force applicable for dilatation is represented by the line *A*.

From the comparative rigidity of the spherical head it can exert but little direct expansive force upon the margins of the os during the early stages of dilatation (Fig. 240)—a fact which explains admirably the relatively slow progress of dilatation after early rupture of the membranes. When, however, the os has so far dilated as nearly to admit the greatest circumference of the head, its action is that of a slightly tapering wedge, by which almost the whole power of the propelling force is transmitted into an outward pressure of the margins of the os, and which must compel an extremely rapid completion of the dilatation * (Fig. 241). It will be seen that in this second form of the mechanism of the first stage the force employed is still that of the general intra-uterine fluid-pressure, but that the dilating agent is now the head.

* It will be seen that this fact is an adequate explanation of the greater frequency of laceration of the cervix when a rupture of the membranes results in the completion of the dilatation by the direct pressure of the rigid head.

After Complete Escape of the Waters.*—The escape of any considerable quantity of the waters usually results in contraction of the uterus sufficient to permit of firm contact between the fundus and the breech of the child. The force of this contact is then transmitted to the head through the vertebral column of the fetus. At first sight it seems unlikely that any considerable force could be transmitted through so flexible a rod as the vertebral column of an unborn child. This transmission is, however, rendered possible by the following conditions: It is an observed fact that during a contraction the long diameter of the uterus, far from being decreased, is actually lengthened. This phenomenon is due to the superior strain of the circular stresses, which by their greater force decrease the antero-posterior diameter of the uterus and thereby † increase its length (Figs. 242, 243); the lateral uterine walls, at the same time, come into strong contact with the surface of the fetal body, and so straighten out the child, thus increasing the violence of the contact between the breech and the fundus, and affording a firm supporting surface which prevents any bending of the vertebræ, and converts the backbone for the moment into a mechanically rigid rod which is fully capable of the transmission of force. When this form of mechanism obtains, the head acts as the dilating wedge, and the second form of force, that furnished by direct contact between the breech and the fundus, is alone active.

FIG. 242.—Diagram illustrating the alteration in the shape of a cross-section of a uterus during its contractions. The heavy line represents the non-contracted, the dotted line the contracted, uterus (compare Fig. 243).

FIG. 243.—Diagram illustrating the alteration in the shape of a sagittal section of the uterus during its contractions. The heavy line represents the non-contracted, the dotted line the contracted, uterus.

Mechanism of Dilatation of the Os with Originally Scanty Waters.—It occasionally happens that the waters are originally so scanty in amount as to permit direct contact between the breech and the fundus to occur early in the first stage. Under these circumstances the head is brought into close contact with the os at the beginning of labor. The mechanical conditions are now closely similar to those which obtain after the escape of the waters, with the single exception that if the membranes are tough and inelastic their tension may somewhat impede the progress of the head.

* This term, though conventional, is inaccurate, as there is almost always some liquor left in the uterus.

† The ovum being incompressible.

Mechanism of Dilatation with Undue Elasticity of the Membranes.—If the membranes are unusually elastic, it may sometimes happen that after the formation of a considerable pouch of membranes in advance of the head, the volume of the uterine contents may be lessened sufficiently to permit the head itself to be brought into close contact with the margins of the os, by the force of a perhaps temporary direct contact between the breech and the fundus. In this position, if the head is in contact with the entire margin of the os, it forms with it a ball-valve by which the "fore-waters" are entirely cut off from the uterine contents. The pressure, *C* (Fig. 244), is now opposed only by the elasticity of the membranes and of the vaginal tissues. The general fluid-pressure is no longer exerted against the margins of the os, and the conditions are mechanically similar to those illustrated in Figure 239.

FIG. 244.—Diagram illustrating the formation of a ball-valve by contact between the head and the edges of the os. The waters behind the head are exposed to the general intra-uterine fluid-pressure, while the fluid-pressure in advance of the head is only created by the elasticity of the fetal membranes.

B. Mechanism of the Second Stage of Labor in Vertex Presentations, O. L. A.

The second stage of labor is commonly divided into three sub-stages: The descent and expulsion of the head; external restitution; and the delivery of the trunk.

The adaptation between the normal head and the pelvis is so close that for the accomplishment of the descent and expulsion of the head there is required the occurrence of a set of somewhat complicated movements which are, in fact, essentially one single complex motion. This motion consists of three elements: (1) The descent of the head through the pelvis; (2) a change from the partially extended position which the head normally occupies at the beginning of labor to one of complete flexion; and (3) lateral rotation of the head within the canal, from the oblique position which the suboccipito-bregmatic diameter occupies at the brim to the antero-posterior position in which it emerges from the outlet. Although it is necessary in discussing this motion to describe its components separately, it must not be forgotten that no one of its parts can proceed to its accomplishment without the coexistence of the others. Thus, descent can be accomplished only during the existence of flexion, while flexion is produced only by the act of descent. So, too, the final stage of descent, known as *expulsion*, is normally impossible without rotation, while rotation occurs only during the descent of a fully-flexed head. The most intelligible way of describing these highly complex phenomena is by a chronological study of the mechanical conditions which occur and succeed each other during the stage of descent and expulsion.

Descent.—It is necessary, in describing the mechanism of the second stage, to begin by considering the action of the forces by which the mechanism of this stage is effected. So long as the fetus is exposed on all sides to contact with the liquor amnii, the contractions of the uterine and abdominal muscles can produce no effect upon it other than that of subjecting it to a uniform fluid-pressure, equal and opposite in all directions. In point of fact, the mechanism of descent does not begin until the presenting part is cut off from the liquor amnii by coming into apposition with the edges of the os. As was implied in the last section, this contact may happen in either of two ways:

First: When the mechanism of the first stage is such that the head comes into close contact with the margins of the os before any considerable quantity of the liquor amnii has escaped from the uterus, it forms with the os a ball-valve (p. 430), by which the remaining part of the waters is retained within the uterus; and the occurrence of descent is then the result of the action of the intra-uterine fluid-pressure. This is the *normal*—that is, the most usual and the most favorable—*mechanism of descent.*

Second: When close contact between the head and the os does not occur until after the complete escape of the waters, the uterine muscle contracts upon the child, and the force of the circular stresses (p. 425) is lost so far as the production of descent is concerned, but the breech and the fundus of the uterus come into contact with each other, and the force of the longitudinal stresses is thus still available. This second form of the mechanism of the second stage is commonly called a "dry labor," and such labors are, with reason, much dreaded by obstetricians, because the loss of the powerful circular stresses usually leads to a protracted second stage.

Normal Mechanism of Descent.—The portion of the head that is without the uterus (R, R', Fig. 239) is opposed only by the resistance of the vaginal tissues. Every other portion of the fetus is exposed to the general intra-uterine fluid-pressure. If it is remembered that fluid-pressures are always equal and opposite, it will be seen that the forces A and B are directly neutralized by the forces A' and B', and that the force C is opposed only by the comparatively trifling resistance of the vaginal tissues. This force (C) is then practically unopposed, and is therefore efficient for descent.

Mechanism of Descent in Dry Labors.—When the escape of the waters has permitted the uterus to contract upon the child, the advance of the presenting part is opposed only by the vaginal tissues, and is favored by the force of all the longitudinal stresses of the uterine muscle; * but unless the descent progresses rapidly a localized contraction (p. 429), due to the unopposed action of the circular stresses, leads to a lessening of the calibre of the uterine canal at any point where the diameter of the child is small—for example, the neck (Fig. 245)—and the descent of the child is then further opposed by the fact

* And by the auxiliary efforts of the abdominal muscles.

that the shoulders must be made to dilate this ring—that is, to overcome the tonic contraction of the circular stresses. In dry labors, then, the force of the circular stresses is not only lost as a factor in the production of descent, but may sometimes also be opposed to it.

Flexion.—At first sight it would seem that the only result to be expected in either case would be the occurrence of descent, and that as the head is normally somewhat extended at the beginning of labor, this descent would oppose to the pelvic diameters the always difficult and frequently impossible occipito-frontal diameter. A somewhat more careful examination will demonstrate, however, that the propelling and opposing forces are already so disposed upon the head as to favor, from the start, the occurrence of flexion, and that the first movement of descent will, under normal circumstances, tend to bring to the brim the much smaller suboccipito-bregmatic diameter. To this end two factors contribute: first and most important, the articulation of the

FIG. 245.—Constriction-ring about the neck of the child (one-sixth natural size).

FIG. 246.—Diagram of head lever.

vertebral column to the skull at a point much nearer to the occipital than to the frontal end of the head; second, the mechanical effects of the irregular shape of the skull.

Unequal Lengths of the Ends of the Head.—The effects of the eccentric position of the occipito-atlantoid articulation must be investigated separately for each of the three forms of force that may be active—that is, for the force of gravity, the general fluid-pressure, and the force of direct contact with the uterine muscle.

Force of Gravity.—Whenever the force of gravity is active, it is evident that the weight of the body will be transmitted to the skull through the occipito-atlantoid articulation. If the fetal head is supposed, at the beginning of this motion, to occupy a position midway between extension and flexion, the occipital and sincipital ends of the head, marked O and F respectively (Fig. 246), will rest against the uterine walls, while the force A is applied at the occipito-atlantoid articulation. Since the force is applied nearer to the occipital end of the head, it is evident that a greater amount of impulse will be communicated to the occiput; and since the resistances are of necessity equal, the occiput will tend to advance more rapidly; but advance of the occiput with relative delay of the sinciput is, in effect, flexion. The head, in fact, becomes a lever of the third class, in which the pressure of the resistances applied to the longer end is more effective in delaying progress than the equal pressure applied to the shorter end of the lever.

It is further to be noticed that as flexion progresses the relation between the lengths of these arms is so altered as to make them progressively more unequal, so that, as the head flexes, the point at which the pressure of the resistance is applied to the occipital end of the head becomes progressively nearer to the vertebral articulation.

General Intra-uterine Fluid-pressure.—If Figure 247 represents the situation of the child at the end of the first stage, we see that the forces A and B are applied directly and with equal force to the ends of the head; but it is evident that the pressure (C) exerted upon the breech of the infant will be transmitted to the head more readily by the vertebral column than by the soft tissues of the trunk, and that a large portion of this force (C) must therefore be concentrated on the condyles. So far as this force (C) is concerned, the argument used in explaining the production of flexion by the influence of gravity applies, then, with equal force to this condition.

FIG. 247.—Diagram illustrating the application of a preponderance of the intra-uterine fluid-pressure to the occipital end of the head. It is evident from the condition of the head lever (see Fig. 246) that the sinciput is exposed to the force B, plus a small proportion of the force C, while the occiput receives the force A, plus the greater part of the force C.

Direct Contact between the Breech and the Fundus.—The whole effect of a direct pressure upon the breech by the fundus will be applied to the condyles of the occiput, and, the resistances upon the occiput and sinciput being of necessity equal, while the opposing forces are concentrated at a point much nearer the occiput, it is evident that the occipital end of the head will tend to advance more rapidly than the frontal end; but advance of the occiput with relative or absolute delay of the sinciput of course results in flexion.

Irregular Shape of the Fetal Skull.—The occurrence of flexion is likewise aided by the second factor referred to above, the irregular shape of the skull. As will be seen by analysis of the opposing forces exerted at R and R' (Fig. 248), if the effect of the equal resistances at R and R' be represented by the length of the equal lines S and S' drawn perpendicular to the surface of the skull at these points (the direction in which these resistances must, according to well-known mechanical laws, be exerted), the construction of the parallelogram of forces shows that the line *T* (whose length represents the portion of the resistance *R* which is exerted in direct opposition to descent) is much greater than that of the line *T′* (which represents the efficient proportion of the resistance *R′*). From this it is evident that the occipital end of the head is exposed not only to greater force from above, but also to less resistance from below, while the sincipital end is opposed by greater resistance and receives a less amount of propulsive power—conditions which can only result in a more rapid advance of the occiput.

As soon as partial flexion has been accomplished a second effect of the irregular shape of the head comes into play, and there must be accorded such importance as is due to it. Figure 249 represents a partially-flexed head

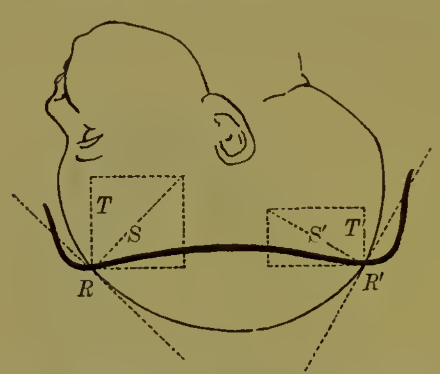


FIG. 248.—Diagram illustrating the influence of the irregular shape of the skull in producing flexion, by the construction of the parallelogram of forces. It is seen that the force which dilates the sinciput, represented by the line *T*, is greater than the force which dilates the occiput, represented by the line *T′*, which represents the sinciput.

FIG. 249.—Diagram illustrating the secondary effect of the irregular shape of the head in promoting flexion after partial flexion has once been produced.

engaged in the elastic canal formed by the lower uterine segment and the vagina.* The forces *A* and *B*, due to the constriction of the elastic canal in which the head lies, and acting necessarily at right angles to the surface of contact, will then form a pair of equal but not opposite forces—in mechanical language "a couple"—the effect of which is to rotate the head upon a transverse axis at *C*, thus increasing its flexion.

It will be noticed that all these causes of flexion † are dependent for their existence on the presence of resistances acting in opposition to the *vis-a-tergo* which urges the head downward, and it necessarily follows from this fact that flexion occurs most rapidly and becomes most marked when the resistances are best developed—a theoretical consideration which is in thorough accord with the observed fact that there is often a temporary loss of flexion in the excavation, where the space is the greatest; that is, that flexion is generally better marked while the head is experiencing the well-developed resistances of

* The fact that the vaginal walls possess at the end of pregnancy intrinsic muscles of considerable development, though too often wholly neglected in the consideration of the mechanism of labor, is, notwithstanding, an element in the production of flexion that must not be forgotten.

† Except the last and least important.

the superior strait than in the excavation, where the resistances are less. So, too, flexion again increases when the head reaches the inferior strait. Flexion is, in fact, normally more marked in this part of the pelvis than in any other; but here another factor comes into play.

We have previously seen flexion produced by the action of the propelling forces against resistances which were exerted with approximately equal force on both the occiput and the sinciput; but when the head reaches the inferior strait its occipital end rapidly frees itself from the pressure of the bones, and is opposed only by the resistances of the soft parts of the pelvic floor, while the sinciput is still exposed to the firm resistance of the bony sacrum. It is evident that when the greater pressure is exerted on the longer arm of the lever extreme flexion is a necessary result. The mechanical explanation is thus in complete agreement with the clinical fact that the deeper is the engagement of the head, the more marked is the tendency to flexion and the greater is the certainty of its accomplishment.

Rotation.—The movements of descent and flexion make up the whole mechanism of the earlier part of the second stage of labor; but another factor —rotation—is necessary to its completion.

The mechanism of rotation is, unfortunately, extremely difficult of comprehension; and, as nothing is more difficult than to teach mechanical problems involving the use of three dimensions without the aid of models, the student will be wise if he supplements the words and figures of any written description by a constant inspection of the dried pelvis and by the results of the intrapelvic touch in actual clinical work. A complete comprehension of the mechanism of rotation is seldom acquired in any other way. The student must, at all events, grasp the fundamental fact that it does occur, and *must always occur*, before expulsion can take place.

The head enters obliquely because the oblique diameters are the largest at the superior strait, but it must emerge in an antero-posterior position—that is, with the sagittal suture opposed to the antero-posterior diameter of the outlet—because the antero-posterior diameter is the largest at the outlet. The movement by which the oblique position at the brim is converted into an antero-posterior position at the outlet is known obstetrically as *rotation*.

To understand the mechanism of rotation it is necessary to remember, first, that with good flexion (without which rotation does not occur) the occipital end of the head is on a lower level than the sincipital; that is, the occiput receives the pressure of the *lower* portion of the anterior part of one lateral wall, while the sinciput receives the pressure of the *upper* portion of the posterior part of the other lateral wall. Secondly, it is necessary to remember accurately the shape, depth, and direction of the spiral grooves described on page 396 (Fig. 218). Thirdly, it must not be forgotten that whenever one end of the head executes a movement of rotation, its other end must, of course, move simultaneously in the opposite direction. As the head enters, O. L. A., in the usual position of moderate flexion at the brim, the occiput is necessarily in contact with the upper part of the anterior groove upon the left side of the pelvis; though the groove is here shallow, the occiput is unable to move away from it, because the bregmatic region lies at this time in the deep sacro-

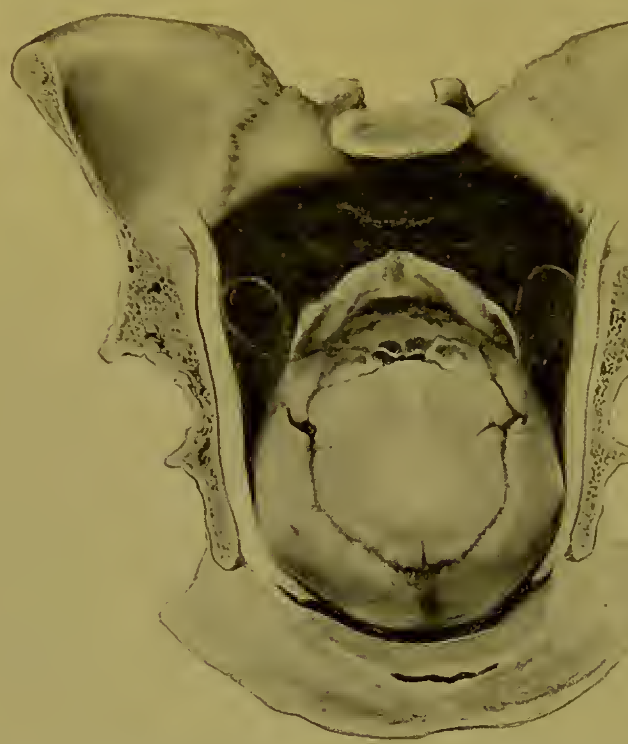


FIG. 250.—Position of the head in the inferior strait after complete rotation. The tuberosities of the ischia prevent any further rotary movement, while further descent is opposed only by the soft parts (one-third natural size).

iliac notch on the right side. As descent goes on the occiput enters the anterior groove more fully—that is, it reaches the point at which the groove

FIG. 251.—Forward motion of the head during the stage of expulsion under the influence of the forward thrust of the sacrum and the pelvic floor (one-sixth natural size).

is too deep to permit an easy escape of the occiput from its guidance—and by the time the occiput approaches the point where the groove turns forward, and where it must itself turn forward to avoid the pressure of the projecting iliac spine, the suboccipito-frontal diameter is in the brim and the sinciput is in the sacro-iliac notch. With the next movement of descent the sinciput slips below the promontory and is in contact with the upper and shallow part of the posterior groove on the right side. The occipito-frontal diameter now occupies the extremely large oblique diameter of the excavation, and the posterior edge of the groove in which the sinciput lies is here so ill marked that, with the great space afforded by the oblique diameter of the excavation, it would be an extremely easy matter for the sinciput to slip backward into the hollow of the sacrum if any force tending in this direction were applied. This force is, in fact, applied as a result of the tendency of the occiput to turn forward along the course of the anterior groove of the left side,* under the impulse furnished by the pressure of the projecting iliac spine against the posterior surface of the occipital end of the head. But when the sinciput has once slipped backward in this way into the hollow of the sacrum, there is nothing left to prevent the occiput from turning still farther forward, until, as it reaches the median line, it receives the thrust of the other side of the pelvis, and is steadied in its

FIG. 252.—Head during distention of the pelvic floor after rotation, with beginning extension (Smellie).

median position by its reception of equal pressures on each side from the descending rami of the pubes and the tuberosities of the ischium.

Expulsion.—The parietal bosses now lie in contact with the tuberosities of the ischium. The narrow temporal diameter corresponds with the narrow transverse diameter of the pelvis between the iliac spines. The sinciput is still in

* It will be remembered that when the occiput turns forward the sinciput must of necessity turn backward.

contact with the lower portion of the sacrum, and the occiput, though steadied on both sides by the bones, finds its descent opposed only by the yielding tissues of the vaginal outlet (Fig. 250). Under these circumstances (p. 432) the propelling force from above concentrates itself upon the occiput until the perineum is fully distended. The occipital end of the head is then freed from the resistances, while the whole bregmatic region and the sinciput form a rigid slanting surface which is opposed to the slanting surface furnished by the sacrum and the perineal tissues (Fig. 251). As a consequence the driving force of the uterine pressure is converted by the shunt of these shelving surfaces into a forward thrust, under the influence of which the head, as a whole, moves forward until its progress is arrested by contact of the nape of the neck with the anterior pelvic wall. The large fontanelle is now at the fourchette, the whole of the occipital half of the head is free from pressure, while the forehead is still exposed to the driving force of the uterine muscle above and to the forward shunt of the posterior pelvic wall. The necessary result is a forward motion of the head with arrest of the neck; that is, the head extends, the bregma, the forehead, and the face successively pass the fourchette, and the head is expelled by extension (Fig. 252). It is then a convenient mnemonic that in normal labor the head descends in flexion and is expelled by extension.

The time occupied by the latter stages of the expulsion of the head—that is, the time between the first appearance of the hairless forehead and the completion of the expulsion—is usually very brief. This rapid motion of descent is usually followed by a period of inaction, which is due to the fact that the decrease in the volume of the uterine contents has been so great as to exhaust the contractile power of the uterine fibres, and to render progress impossible until after the occurrence of the peculiar phenomenon known as *retraction.*

Retraction of the Uterus.—It is well known that the amount of shortening possible to any given muscular fibre is very definitely limited, and it is believed that the extreme shortening of the uterine muscle as a whole that is observed during labor is rendered possible by a process of rearrangement of the relations of the fibres of the uterine muscle to one another, known as *retraction.* The way in which this process is effected is not definitely and scientifically known, but the conception generally accepted as a working hypothesis is that the cells of the uterine muscle not only shorten, but rearrange themselves upon one another in some such way as that diagrammatically represented by Figure 253, A and B. When retraction has once taken place it is usually permanent, and the distinction between contraction and retraction, whatever it may mean pathologically, is therefore clinically

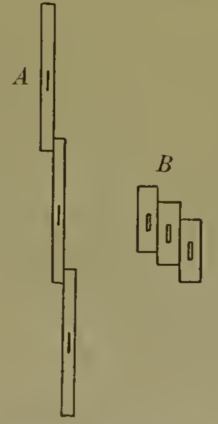


FIG. 253.—Diagrams representing the hypothetical relations between the uterine fibres in unretracted and retracted uteri: A, arrangement of the uterine fibres in the unretracted uterus; B, arrangement of the uterine fibres in the retracted uterus.

one which it is important to understand and to bear in mind. In the description of the mechanism of labor it is necessary to refer to retraction as an established entity, notwithstanding the unestablished position of the hypothesis upon which rests its existence.

When, after the expulsion of the head, retraction of the uterine fibres has been effected, the rhythmic contractions again set in and the process of expulsion of the body begins.

Expulsion of the Body: Rotation of the Shoulders.—The shoulders having entered the pelvis during the expulsion of the head, they are usually born with the next few succeeding pains. The head having entered in the *first* oblique diameter, it is evident that the shoulders, which normally lie at right angles to the antero-posterior diameters of the head, will normally enter the pelvis in the *second* oblique diameter. As the shoulders are driven down by the pains, the anterior shoulder follows the curved line of least resistance, previously travelled by the occiput, while the posterior shoulder follows the path of the sinciput. The anterior shoulder thus rotates to the arch, and the transverse axis of the shoulders occupies the antero-posterior diameter of the outlet.

Restitution of the Head.—The head, being now free from pressure, tends to retain or reassume its natural relation to the shoulders, and thus as they assume an antero-posterior diameter the already expelled head undergoes an external rotation by which the occiput is carried to a position opposite the left, and the sinciput to one opposite the right, buttock of the mother. This proeess is known as the *external rotation* or restitution of the head. The shoulders are, however, so small and soft as compared with the head that the mechanism of their rotation is not infrequently faulty or irregular. It may, moreover, happen that at the time of their entrance the action of the intrinsic muscles of the child may have so turned the body that the transverse axis of the shoulders lies at an aeute angle to the antero-posterior axis of the head. The small and soft shoulders may from this cause enter the pelvis in the transverse, or even in approximately the first oblique, diameter. The shoulder which should normally have been the posterior may thus become the anterior, and in this way lead to such an exeessive external rotation of the head that the occiput swings around to the right buttock of the mother. This faulty process is commonly known as *super-rotation.*

Expulsion of the Shoulders.—The shoulders being retained in the antero-posterior diameter by the pressure of the tuberosities, the posterior shoulder receives the forward shunt of the pelvic floor, which, together with the curvature of the body necessary to admit of the passage of the curved pelvis, jams the anterior shoulder against the symphysis pubis in such a way (Fig. 254) that the posterior shoulder sweeps forward over the perineum and is the first to reach the vulva. As the body is urged onward the perineum retracts, the anterior shoulder appears from beneath the arch, the shoulders emerge from the vulva, following the direction of the curve of Carus (Fig. 219), and the remainder of the body rapidly follows in the same path. During the process of expulsion the arms normally remain crossed upon the chest in the usual attitude of the fetus, but they are not infrequently held back by the friction of the pelvic wall, and are thus forced into a position of partial extension in which the forearms lie across the abdomen.

The mechanism of the second stage in O. D. A. positions differs from that

FIG. 254.—Expulsion of the shoulders.

of O. L. A. only in the substitution of the word right for the word left throughout the description.

C. Mechanism and Management of the Third Stage of Labor.

Mechanism of the Third Stage of Labor.—After the expulsion of the child the uterus shuts down upon the placenta, and there is usually a period of from five to ten minutes during which little or no contraction is apparent, this interval being occupied by the process of retraction of the uterine fibres. The first active contractions of the uterus after the expulsion of the child necessarily lessen the area of the uterine surface over which the placenta is attached, and thus in part or in whole separate the placenta from the uterine wall; during the next relaxation blood escapes from the torn sinuses in the placental site, and the mechanism by which the placenta is expelled depends upon the escape or non-escape of this blood from the uterus.

If the first retraction is sufficient completely to detach the placenta, but does not succeed in expelling it, any blood which may be effused will usually find its way to the external world by dissection of the membranes from the uterine wall; during the next few contractions the uterus will be able to shut down upon the placenta, and will compel it, by the force of direct contact, to pass through the os edgewise and in the most compact possible form—that is, in the shape shown in Figure 255, in which the thin cake-like placenta is seen to have been folded upon itself in a roughly fusiform shape.

When, however, the attachment of the placenta is too firm to permit an immediate separation, or when, as probably more frequently happens, the contraction of the fundus is more energetic than that of the lower portion of the uterus, so that only the upper portion of the placenta is detached, the relaxation following each contraction will be accompanied by an effusion of blood which is confined behind the placenta. The upper part of the placenta will then be forced downward, and as the detachment proceeds the position of the placenta will be so far altered that its fetal surface presents at the os, the uterine cavity behind it being occupied by a mass of blood (Fig. 256). When this occurs,

FIG. 255.—The more favorable mechanism of expulsion of the placenta (Varnier).

the placenta presents in so much more bulky a form that it is usually expelled so slowly and with so much difficulty that the process is not completed until the effused mass of blood attains sufficient size to redistend the uterus slightly,

FIG. 256.—The less favorable of the common methods of expulsion of the placenta (Varnier).

and thus permit of the occurrence of more forcible contractions. The placenta is then expelled, not by the force of direct contact, but by an intra-uterine fluid-pressure exerted through the mass of effused blood.

This second form of the mechanism of the third stage of labor, though essentially normal, is much the less easy and favorable for the patient; although the amount of blood lost is not usually sufficient to effect any perceptible alteration in her pulse.

In either mechanism the elastic and collapsible nature of the membranes renders them less likely than the placenta to be thoroughly detached, and as the latter emerges through the hole in the membranes that corresponds with the os they are necessarily inverted, and, becoming detached by the traction due to the advance of the placenta, follow after it in a loose mass.

Management of the Third Stage of Labor.*—The inquiry naturally arises: How far is it within the power of the obstetrician to favor or to compel the occurrence of the mechanism first described? To this inquiry it may be answered that the maintenance of a careful watch upon the uterus by constant touch of the fundus through the abdominal wall, and the institution of rapid but light friction with the fingers upon the fundus during the first contraction, usually so far increase its duration and force as often to effect the complete separation of the placenta. Moreover, if this friction is persisted in throughout the succeeding period of relaxation, it will usually maintain sufficient contraction to prevent any considerable effusion, and secure separation during the first or the immediately succeeding pains. This most essential portion of the method of Credé should therefore uniformly be adopted.

The second and less favorable mechanism is probably safer for the patient than any manual method of removal of the placenta, but in case a delay in the third stage, notwithstanding the adoption of Credé's method of expulsion, should require the introduction of the hand, a digital intra-uterine examination should first be made, and if the placenta is found to present in the way shown in Figure 256, an effort should be made to reach the edge of the placenta with the finger. It may then be possible to draw the edge of the afterbirth into the os, and thus permit its ready expulsion without the complete introduction of the hand.

D. Mechanism and Management of the Posterior Positions of Vertex Presentations.

Mechanism of Right-posterior Positions.—In the right-posterior positions of vertex presentations the head always enters the pelvis O. D. P.; it should invariably enter the inferior strait in a right-anterior position; but the process by which this rotation is accomplished is, unfortunately, so delicately balanced that it is always liable to a failure, and this, if it occurs, necessarily results in a persistence of the posterior position, which, though not incompatible with a natural delivery, is attended by greatly increased risks to both mother and child.

We have to consider, then, first, *the entrance of the head into the pelvis in posterior positions;* secondly, *the normal mechanism of the subsequent delivery by rotation;* and thirdly, *the* (abnormal) *mechanism of the delivery of a persistently posterior occiput.*

Labor in posterior positions is usually longer and more difficult than in anterior positions, for two reasons: first, because the entrance of the head into the pelvis is more difficult; and second, because, even under the most favorable circumstances, labor is sure to be lengthened by the more extended rotation of the occiput that is necessary to its completion.

The *difficult entrance of the head at the brim in occipito-posterior positions* is due to the existence of two factors, one of which is physiological, while the other is mechanical. The physiological factor is to be found in an irregular

* For the management of the first and second stages of normal labor, see page 367.

and imperfect action of the pains, that characterizes the first stage of labor in a large proportion of posterior positions. The exact cause of this well-marked feature of such cases is unknown. Probably it is a reflex phenomenon due to pressure, from the mechanical mal-adaptation shortly to be spoken of; but it is a fact that a long first stage, which is due to irregular, variable, and ineffective pains, is always suggestive of a posterior position.

The mechanical factor is due to the irregular shapes of the fetal head and the pelvic brim. If parallel diameters are drawn across the pelvic brim (Fig. 257), the one (A) from the right side of the sacral promontory to the right ilio-

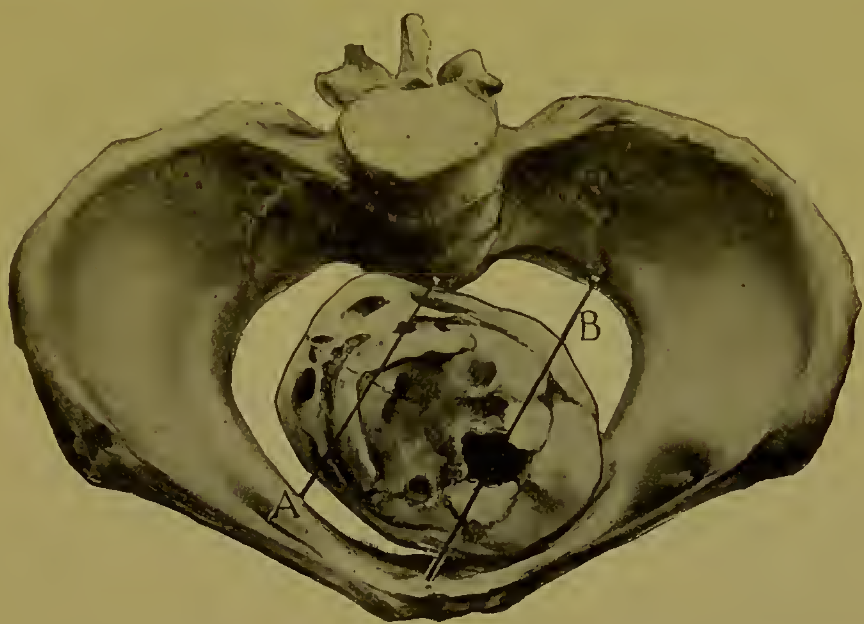


FIG. 257.—Adaptation between the fetal head and the brim of the pelvis in anterior positions of the occiput.

pectineal eminence, and the other (B) from the left sacro-iliac notch to the pubes, it will be seen that when the head enters O. L. A., the wide biparietal diameter of the head corresponds with the greater space afforded by B, the longer of these diameters; while the lesser bitemporal diameter is in correspondence with A, the shorter of these parallel diameters.

The entrance of the head is therefore mechanically easy in anterior positions; but, conversely, when the head enters O. D. P., its wide biparietal diameter is opposed to the narrow oblique space between the promontory and the ilio-pectineal eminence of the right side, while the narrow biparietal diameter is loosely fitted into the wide space afforded by the anterior portion of the pelvis (Fig. 258). Two factors of difficulty are thus produced: first, the widest portion of the fetal head finds itself in apposition with a narrow portion of the pelvis, and therefore requires a powerful driving impulse to force it through the brim; second, this retarded widest portion of the head is situated on the occipital end of the head lever, while the sincipital end is almost free. This situation, therefore, always tends toward a too rapid descent of the sinciput—that is, toward the production of extension—but the degree of extension produced varies with the relative sizes of the pelvis and the head.

If the disproportion between the biparietal diameter of the head and the portion of the pelvis in which it finds itself (that is, A, Fig. 258) is not extremely great, the production of an extension sufficient to cause a light pressure of the forehead against the pubes may be enough to equalize the

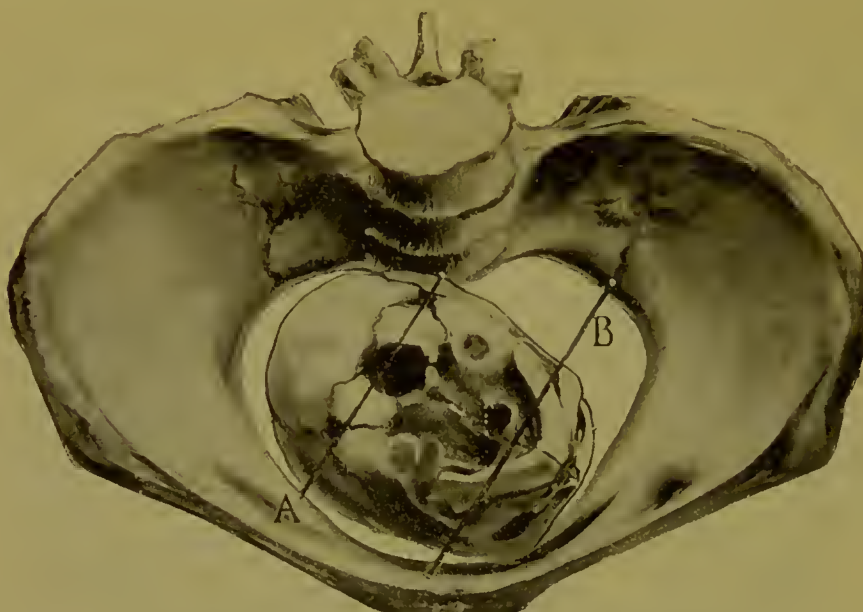


Fig. 258.—Adaptation between the fetal head and the brim of the pelvis in posterior positions of the occiput.

resistances at the opposite ends of the cephalic lever, and may thus permit the greater propulsive force applied to the occiput (see page 433) to accomplish its descent while the sinciput is still above the brim. The head in this case will enter the excavation in a fairly well flexed condition.

If the disproportion between the occiput and the posterior portion of the pelvis is more extreme, the process of extension will continue until the occipito-frontal diameter occupies the first oblique diameter of the brim. The head may then pass the brim, after long labor, in an extended position;* it may be arrested at the brim by becoming a brow presentation, or it may exceptionally be converted into a face presentation.

Passage of the Excavation.—After its escape from the superior strait the head occupies the first oblique diameter of the excavation O. D. P., and the accomplishment or non-accomplishment of the remainder of the labor by the normal mechanism of rotation depends wholly, and only, on the degree of flexion present.

Rotation in Well-flexed Right-posterior Positions.—When the occiput enters the excavation—that is, passes below the promontory—while the sinciput is still delayed in or above the brim, it occupies for the moment so roomy a posi-

* It will be remembered that the occipito-frontal diameter is too large to pass even the oblique diameters at the brim with ease.

tion that it is enabled to descend rapidly almost to the floor of the pelvis, while the sinciput, delayed by the pressure of the anterior pelvic wall, makes but slight progress. The occiput then lies between the sacrum and the right ischium, in the hollow made by the recession of the elastic sacro-sciatic ligaments—that is, in the deeper portion of the posterior groove of the right side of the pelvis—while the sinciput is pressed against the smooth and uniform surface of the upper part of the anterior portion of the lateral wall on the left side. As descent goes on the occiput follows the posterior groove forward under the pressure of the unyielding bony edge of the sacrum, which presses against its posterior surface; this motion is unopposed by the sinciput, which in thoroughly well flexed heads is still so high in the pelvis that it is free to turn backward over the smooth bony surface of the upper portion of the lateral wall (portion A, Fig. 217, A and B, Fig. 218). Rotation thus progresses smoothly, and usually rapidly, until the occiput reaches the spot at which the posterior and anterior grooves of the right side join, and thus assumes an anterior position. The sinciput, which has by this time become well posterior, now lies in the upper portion of the posterior groove of the left side. The head is now in an O. D. A. position in the lower portion of the pelvis,

FIG. 259.—Diagram illustrating the possible reproduction of flexion in partly extended posterior positions of the occiput. The force of rotation is represented by the arrow A; the portion of that force which is applicable to flexion, by the line B.

and the remainder of the mechanism, including restitution, is exactly similar to that which would have obtained in an originally O. D. A. position (see pp. 430–440).

Mechanism of Rotation when the Head enters Poorly Flexed in Right-posterior Positions.—When more marked, but not extreme, extension occurs across the brim before the passage of the occiput, the release of the latter, as before, permits it to make a rapid descent until it is arrested by contact with the pelvic floor; but at the time when the occiput begins to feel the forward impulse of the deep lower portion of the posterior groove of the right pelvic wall the sinciput is not, as before, in contact with the smooth surface of portion A of the left lateral wall, but has, on the contrary, already entered the upper portion of the anterior groove on that side. Under these circumstances rotation may exceptionally be accomplished. When this does happen the mechanism is as follows: As the occiput is urged forward, the posterior side of the sinciput is pressed firmly against the slightly rising edge of the upper portion of the anterior groove, and under favorable circumstances this increased pressure may result in flexion of the head in the manner illustrated in Figure 259, which is a horizontal section of the pelvis through the spot where the sinciput impinges against the lateral wall. The rotation force due to the forward motion of the occiput urges the sinciput backward in the direction of the force represented by the arrow A. If upon this arrow we construct the parallelogram of forces, we see that by the shunt of the shelving surfaces of the sinciput and the pelvic wall there is produced a small pressure (B) upon the sinciput that tends directly to flexion, and that may, under favorable circumstances, actually produce flexion to a degree sufficient to permit the sinciput to slip by on to the smooth surface of portion A (Fig. 217). The sinciput is free to then glide back into the posterior groove as the occiput moves forward, and the mechanism of rotation described above goes on as before.

This process, however, is mechanically so extremely difficult that it can occur only under the most favorable conditions—that is, when the adaptation is easy, when the pains are powerful, and, most important of all, when the loss of flexion is so extremely slight that but a slight change is needed to restore it.

Mechanism of Rotation when the Head enters Unflexed in Posterior Positions: the Mechanism of the Passage of the Excavation in Persistent Right-posterior Positions.—When the head passes the brim so far extended that the sinciput is as low, or nearly as low, in the pelvis as the occiput, the forehead reaches the deeper portion of the anterior groove at about the same time that the occiput reaches the deeper portion of the posterior groove. Both ends of the head are then urged to rotate forward by the forward trend of their respective grooves; since neither one can rotate forward unless the other turns back, there results a dead-lock which can be broken only by the intervention of art—that is, by a manual or an instrumental flexion of the head. In rare cases, however, this dead-lock may be avoided by the occurrence of a second and abnormal mechanism, by which the occiput is rotated directly backward into the hollow of the sacrum. This rotation can occur only when the adaptation between the head and the pelvis is exceptionally easy, when the sacrum is exceptionally hollow, and when its lateral concavity is but little marked. The occurrence of a backward rotation is then due to the fact that the posterior edge of the anterior groove, formed by the ischiatic spine, is more prominent than the corresponding portion of the posterior groove, formed by the edge of the sacrum. If, under these circumstances, the occiput and the sinciput are at equal depths in the pelvis, it results that the sinciput is more firmly fixed in the anterior groove than is the occiput in the posterior; and if the adaptation is exceptionally easy or the lower portion of the sacrum is wanting in prominence, the occiput may be able to escape from the posterior groove and turn backward over the sacrum as the sinciput rotates forward. This escape of the occiput into the hollow of the sacrum usually so far diminishes the pressure on the occiput as to permit of its rapid advance, while the descent of the sinciput is still delayed by the normal resistances of the anterior wall of the pelvis. The rapid descent of the occiput as compared with the sinciput thus re-establishes flexion, with the head in a directly occipito-posterior position. Expulsion of the head in a persistently posterior position by the natural forces or by the aid of forceps is then possible, though the conditions are much less favorable than when the occiput is rotated forward, as may be seen by reference to Figure 260. On comparing

FIG. 260.—Expulsion of the head in persistently posterior positions of the occiput; mechanism of face to pubes delivery.

Figure 260 with Figure 251 it will be seen that when the occiput is anterior the curved axis of the child's head and body corresponds with the curved axis of the pelvis, but that when the occiput is posterior these curves are reversed upon each other, and that to effect the delivery in this position the uterine forces must alter the shape of the child by elongating the occiput, by compressing the sinciput, and by producing an exaggerated flexion until the normal curve of the fetal axis is reversed. Although the fetal head is surprisingly tolerant of the excessive compression necessary for this change of shape, the process always results in the stillbirth of a large proportion of the children; while the prominence of the occiput, even after the most extreme moulding, always exposes the soft tissues of the pelvic floor to a degree of tension that almost invariably results in deep laceration of these structures during the stage of expulsion. The expulsion of a persistent occiput posterior, moreover, always requires, in addition to lax adaptation, the presence of very powerful uterine contractions or the application of powerful traction by the forceps; and even when these conditions are present the process is a long one.

The head remains in position until the processes of the change in its shape and the production of extreme flexion are sufficiently far advanced to permit the occiput to travel downward along the median line of the posterior wall under the influence of the pressure from above. The region of the small fontanelle finally appears at the vulva, and the perineum retracts, or, more commonly, tears across the occiput to the base of the neck. The occipital end of the head is then free from pressure, while the sincipital end is still exposed to the driving force of the uterine contractions. The excess of pressure upon the sincipital end of the head then causes extension, by which the forehead, the eyes, the nose, and the chin successively appear under the arch, while the occiput swings backward, and the head is born by extension (Fig. 260).

Restitution.—During the expulsion of the head the shoulders enter in the second oblique diameter, and the rotation of the left (the anterior) shoulder to

Fig. 261.—Occipito-posterior position, with the head beginning to distend the pelvic floor (Smellie).

the arch produces an external restitution to the right, in accordance with the general law that external rotation or restitution restores the head to its original position. Abnormal or so-called "super-rotation" is, however, of especially common occurrence in these cases.

Summary.—In reviewing the mechanism of posterior positions it is at once apparent that the whole key to the situation is to be found in the degree of flexion presented—that the better the flexion the more certain and the more rapid is the execution of the normal and most favorable mechanism. It is an established fact in practice that in the comparatively few cases in which good flexion is established at the start and maintained to the end, posterior labor is hardly less favorable than anterior; and that the degree of difficulty increases as the degree and persistence of flexion decrease, until we reach the fact that when flexion is lost and is not promptly restored by art, posterior positions invariably yield long, difficult, and exhausting labors for the mother, and a large proportion of stillbirths among the children. It may safely be said that there is no variety of labor in which easily-avoided ill results are so commonly incurred as in posterior positions of the vertex; and there is certainly no subject in obstetrics that better deserves the attention of the student than the means of detecting extension and of preserving or re-establishing flexion in these cases.

Mechanism of Left-posterior Positions.—Of the mechanism of O. L. P. positions it is only necessary to say that it differs from that of O. D. P. positions simply in the substitution of one side of the pelvis for the other, and in the fact that failure of rotation is more common in left positions.

Management of Labor in Posterior Positions of the Vertex.—*Prophylaxis.*—Since posterior labor is so much less favorable than anterior, it is evident that every effort should be made to prevent the occurrence of posterior positions, or, when they do occur, to convert them into anterior positions before the occurrence of labor or during its early stages. We are, fortunately, able to effect this end in the great majority of cases, provided the position is diagnosticated before the rupture of the membranes or the engagement of the head. For this reason, if for no other, the obstetrician should in every case endeavor to ascertain the position of the fetus by making an abdominal palpation some days before the advent of labor. If a posterior position is discovered at this time, it is usually possible to rectify it by postural treatment of the patient.

If the patient is placed in the knee-chest position, the anterior wall and the fundus are the lowest portions of the uterus. So long as the patient remains in this position there is a tendency for the child to sag away from the brim under the influence of gravity; and since the recession of the head from the brim leaves the child free to turn upon its own axis, while the presence of the spinal column makes the dorsal side the heavier, there is also a tendency toward a rotation of the fetus as a whole until its dorsum is in apposition to the anterior wall of the uterus.

The woman should in such cases be instructed to assume the knee-chest posture several times daily during the last few weeks of pregnancy, to remain as long in this position as is possible without fatigue, and, on relinquishing it, to recline on the right side for a short time before rising, in the hope that as the child's head again settles down against the brim it may become fixed in an anterior position.

The enlarged abdomen of the gravida at term may prevent the assumption of the true genu-pectoral position and compel her to adopt the knee-elbow attitude; but in either event it is essential that the abdomen should be free from pressure against either the bed or the thighs of the patient; that is, the thighs should be vertical (Fig. 262).

The postural treatment is especially powerful when instituted before any labor-pains have occurred. If this treatment is conscientiously carried out for several days, the physician will almost surely find the position anterior when summoned to the patient in labor.

Even if the patient is not seen until labor is present, it is still worth while to adopt a postural treatment so long as the membranes are unruptured and the head is unengaged. The patient should then be encouraged to maintain this position so long as her strength permits, or until a vaginal examination without alteration of her attitude demonstrates the fact that rotation has occurred. She should then be placed in the latero-prone position upon the side to which the occiput is directed, and should remain in that position until the head is firmly engaged in the new position. Should the head, after once becoming anterior, show any tendency to revert to the posterior position, it may even be wise to rupture the membranes in order to prevent any such reversion.

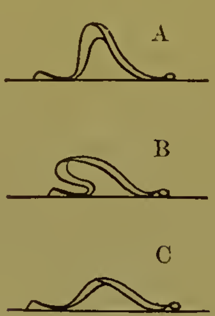


FIG. 262.—Correct (A) and incorrect (B and C) methods of assuming the genu-pectoral position.

Should the postural treatment fail, no special treatment is necessary until after the rupture of the membranes has occurred; but both before and after rupture frequent examinations are advised, in order to detect early any tendency to the production of marked extension.

Passage of the Superior Strait.—In the majority of cases the head in posterior positions passes the superior strait by the natural efforts only after some delay, and often only after the occurrence of some extension and of considerable moulding of the head.

The attitude of the physician should be determined by the degree of extension presented. When the extension is not extreme, he should not be alarmed by a failure of progress, but should avoid interference, and expect the best results so long as the condition of both patients remains good.

When extension becomes so extreme that the eyebrows are below the brim of the pelvis, there is but little prospect that the head will pass the superior strait by the natural efforts, and unless active progress is present it is wise, after a single hour has passed without alteration of the condition, to abandon the expectant method of treatment and resort at once to the operative treatment of a high arrest of the posterior occiput.

Operative treatment at the superior strait subdivides itself into the operative re-establishment of flexion and the delivery through the superior strait of the flexed but arrested head.

Operative Flexion.—If, at the time when operative flexion becomes necessary, the membranes are still intact, it may occasionally be possible to raise the forehead by making pressure upon it with two fingers placed within the cervix, the woman being in the recumbent or knee-chest position, in order to afford the assistance of gravity to the efforts of the accoucheur. Since it is impossible, however, to obtain complete flexion of the head in this way, and since the extension is almost certain to recur if no further change is made, it is essential that the head as a whole should be freed from the brim by pressure upon the vertex, after flexion has been secured, in the hope that on its entrance it may be better situated, and may thus be able to maintain its flexion.

Should extension again recur, it is best to etherize the patient, introduce the hand into the vagina, and dilate the os manually to a degree sufficient to permit the passage of the half hand within the uterus. Should the membranes be ruptured at the time when interference is decided upon, this must usually be the first maneuvre. When sufficient dilatation has been attained, the half hand should be passed within the os until the fingers cover the forehead, which should then be pressed gently upward until complete flexion has been secured and the head has been freed from the brim. The hand should then be withdrawn, the fingers placed as high upon the forehead as possible in order to maintain flexion, and the head forced into the brim by external pressure. The ether should be removed, and the fingers should maintain pressure upon the anterior portion of the head until a firm engagement in a flexed position has been effected by the efforts of the uterus. Should extension become re-established, an operative delivery of the head is necessary.

Operative Delivery of a High Arrest of the Posterior Occiput.—If extension is present, flexion should be established by the introduction of the half hand. Three methods of delivery are then possible: The child may at once be turned, the head may be rotated manually and forceps applied to the anterior occiput, or forceps may be used while the occiput is still posterior.

The latter method is to be recommended only when the other methods are, for one reason or another, contra-indicated or impossible, and the choice ordinarily rests between the procedures of a manual rotation of the occiput to the front with a subsequent application of the forceps, and version.

Manual rotation and the application of forceps is a difficult, and version in normal pelves is an easy, operation. The head after manual rotation not infrequently returns to its original position during the manipulations incident to the application of the blades, and in any event it is necessary to apply the forceps to the head when freely movable above the brim, which operation is always difficult. The writer believes, however, that after the forceps has successfully been applied to the head in an anterior position, an extraction with it is less dangerous to the soft parts of the mother than is the extraction of an after-coming head; the forceps operation should therefore, in his opinion, be chosen by those who are thoroughly skilful in the use of the instrument, but the primary performance of version should be elected by operators of small experience.

Should manual rotation and the use of forceps be decided upon, the whole hand should be passed into the uterus and the head be raised gently until the whole surface of the hand can be applied to the forehead, the fingers lying over the face of the child; whereupon the hand and the forearm of the operator should be rotated with the head until the occiput is well anterior to, and even, if possible, to the left of, the median line. During the introduction of the hand careful counter-pressure must be made at the fundus by an assistant or by the other hand of the operator, and during the rotation the external hand must be used to promote the rotation of the trunk. The rotation should always be slow and be procured with the utmost gentleness. Unless the rotation of the trunk accompanies that of the body, the head will return to its original position as soon as it is free from pressure. In difficult cases it may occasionally be permissible to apply the internal fingers to the shoulder of the child to promote this rotation. The whole maneuvre is frequently so difficult that, unless the waters have been but recently evacuated, it should not be attempted until a fair experience in version has furnished the operator with some adroitness in intra-uterine manipulations.

After rotation has been effected the head should be urged into the brim by counter-pressure upon the fundus, and it should be maintained in position by gentle abdominal pressure upon the head itself, from the hands of an assistant, while the forceps application is made. The forceps should be applied, if possible, to the sides of the head, and, as in all high operations, the use of an axis-traction instrument is to be recommended.

If *version* is decided upon, the head should be flexed before it is raised, as this always requires less force than an attempt to raise the extended head.

If version is absolutely contra-indicated and manual rotation fails, an attempt should be made to bring the head through the superior strait by the *application of forceps without alteration of the position;* but as a preliminary even to this operation an extended head should gently be flexed.

In the use of forceps while the occiput is still posterior, it is inadvisable to make any attempt to apply the blades to the sides of the head, as the position of the parietal bosses in the narrow space between the ilio-pectineal eminence and the promontory makes it extremely difficult to adjust the forceps to the ends of the biparietal diameter. Even when it is so adjusted a very slight forward inclination of the line of traction may cause the forceps to slip forward along the head to the temporal region. In this position the forceps is extremely likely to slip from the head altogether; even if the forceps holds its position, the sole and necessary result of traction is a reproduction of the extension, which, of course, results in an arrest, or at least requires the use of increased and unnecessary force. The blades should therefore be applied to the sides of the pelvis, where they will take an oblique grip upon the head. This application is always very difficult, and the operation too frequently results in a fracture of the skull or in the birth of a stillborn child from cranial compression. As soon as the head has passed the brim the forceps should be removed; if necessary, the forceps may be reapplied in the manner shortly to be recommended for the operative treatment of the low head in posterior positions.

Management of the Passage of the Excavation in Posterior Positions.—Flexion.—As was said in the discussion of the mechanism of posterior positions, the maintenance of complete flexion is the first and most essential condition of the progress of the head through the excavation. It follows that the maintenance of flexion when possible, and its re-establishment when it has been lost, must demand throughout the case the most careful attention from the obstetrician.

When the adaptation is easy and good flexion is present from the start, descent and rotation to an anterior position are sometimes so quickly performed that no assistance is needed; but in a large proportion of cases the head enters the excavation in a condition of partial extension, and in such cases an early adoption of certain very simple measures frequently makes the difference between difficult and easy labors. The various expedients which may be used to promote or to re-establish flexion form, then, the first and most important division of the treatment of the low head in posterior positions; but, since it not infrequently happens that even a well-flexed head fails to rotate from over-tightness of adaptation, from relative inefficiency of the pains, or from minor variations in the shape of the head and the pelvis, it is necessary to add thereto a second division, which consists of the expedients that may be employed to favor or to produce rotation during extraction, whenever, from any cause, a well-flexed head is arrested in a posterior position in the excavation.

Maintenance of Flexion.—Unless progress goes on with unusual rapidity, the maintenance of flexion by counter-pressure should be undertaken as soon as the head has entered the excavation and the forehead is within easy reach. As soon as the degree of descent permits, the fingers should be placed against the frontal bones as far forward of the large fontanelle as the pelvic space allows, and any further descent of the sinciput should be retarded by a maintenance of pressure against the forehead throughout the whole of each pain until the occurrence of rotation carries the frontal bones backward and out of the reach of the fingers. In this process a simple retardation of the descent of the sinciput is all that is to be aimed at or desired, since flexion is supposed to be already present, and its maintenance is all that is needed. This maintenance of flexion, which is unusually easy, is always a very much more simple matter than is an attempt to raise the forehead by pressure after extension has once occurred. If this precaution is carefully observed from the start, loss of flexion is extremely rare, and a recourse to the more heroic methods required for its re-establishment may usually be avoided.

Re-establishment of Flexion.—When extension occurs, it must be reduced before any further progress is possible. Flexion may be re-established either by pushing the sinciput up, by drawing the occiput down, or by a combination of both methods. The forehead may occasionally be made to recede by pressure upon the frontal bones with the fingers; it should then be held in position until the uterine efforts have effected complete flexion by descent of the occiput, and until rotation has occurred. This method, the simplest and safest, is, however, possible only in very easy cases.

It is occasionally possible to reinforce this method by hooking the fingers of the hand around the occiput, and thus drawing down upon the occiput with one hand while the sinciput is pressed up by the other hand. This method is possible only when the extended head is very low and the soft tissues of the outlet are very lax; in the majority of cases in which extension has fully been established it is necessary to resort to instrumental methods.

The vectis (Fig. 263), which was the precursor of the forceps, was originally used to promote the descent of the head by the application of leverage motions to the sides of the head in alternation. The vectis is never used to-day except for the reduction of extension, and, in the opinion of the writer, cannot be recommended even for this purpose, since, in the first place, its efficiency depends on its possession of an exaggerated cephalic curve which renders its introduction difficult, and, in the second place, it can rarely be prevented from slipping, without the use of a degree of force which exposes both the vagina of the mother and the scalp of the child to serious risks of laceration. If employed, the vectis is passed around the occiput and is used to draw it down, while the delay of the sinciput is entrusted to the friction of the pelvic walls or to counter-pressure by the fingers. For this purpose the hand of an assistant must be utilized, since the employment of the vectis always requires both hands; that is, while one hand makes traction on the handle of the vectis, the fingers of the other hand must always be placed between the vagina and the instrument to protect the tissues from laceration.

FIG. 263.—The vectis.

Reversed Forceps.—A far better operation, when manual efforts at flexion have failed, is to be found in the application of reversed forceps. This operation is in reality a mere extension of the ancient principle that the tips of the forceps should always be directed toward the leading point on the presenting part; but when the forceps is applied to an extended head in a posterior position with the tips directed posteriorly, its grasp is directed so far toward the occipital end that the instrument is almost certain to slip after flexion has occurred. It is therefore important to remember that this application should be utilized only for the production of flexion, that during each traction the fingers of the unemployed hand should carefully note the motions of the head, and that as soon as flexion has been established the blades should be removed, if necessary being reapplied for the delivery of the head in the manner recommended for the delivery of a well-flexed head in posterior positions.

Technique of the Application of Reversed Forceps.—The forceps should be placed outside the vulva, in the position in which they are to lie when applied to the head—that is, with the transverse axis of the blades at right angles to the sagittal suture, and with the tips directed backward. If the lock is of the ordinary form, the handle of that blade which would be the left in the ordinary position should be held in the right hand, and, under the guidance of two fingers of the left hand, should be inserted into the vagina and passed into position as near as possible to the occipital end of the head (Fig. 264).

Fig. 264.—The application of reversed forceps. The arrow indicates the effect of the forceps in promoting the descent of the occiput while the sinciput is delayed by friction against the anterior pelvic wall.

The other blade should be adjusted to correspond with its fellow, and simple traction upon the handles should be made in the direction of the handles, all leverage motions being avoided. The force of the instrument is then directed against the occipital end of the head alone; the sinciput is delayed by the friction of the pelvic walls, while the occiput descends under the force of traction, and flexion results.

As soon as the small fontanelle has been brought to the centre of the pelvis—that is, when the head has been flexed—the forceps should be removed and the process of rotation be entrusted to nature, since lacerations of the vagina are far less often produced when rotation is effected by the uterine force than when it is procured by instrumental means; unless, indeed, the condition of the patient necessitates an immediate delivery.

Low Forceps in Well-flexed Heads in Posterior Positions.—When rotation fails notwithstanding the presence of good flexion—that is, when a well-flexed head is delayed in a posterior position until the signs of exhaustion occur—this failure is usually the result of a relative want of *vis-a-tergo*, which must be compensated for by the substitution of the *vis-a-fronte* of the forceps; but it is the first essential to success in this operation that the instrument should be so applied that its presence in the vagina offers no impediment to the rotation of the head. If in this position of the head the forceps is applied to the sides of the pelvis, its oblique grasp upon the forehead and the occiput will almost certainly prevent rotation; while, even if it is applied to the sides of the head, it is liable to cause extension and consequent delay, with laceration of the perineum, and frequently the death of the fetus, unless special precautions are taken to ensure its grasping the occiput.

So long as the occiput is distinctly posterior to the transverse line of the pelvis, the forceps should be applied to the sides of the head with the concavity of the pelvic curve toward the forehead—that is, with the tips anterior; but care should be taken during the application of the blades to keep the handles well raised, or, to use a better expression, to direct the tips far backward into the pelvis, in order to ensure their grasping the occiput and thus promoting rather than retarding flexion during the tractions. The tractions should be directed as far backward as the perineum will allow, at least until rotation has occurred; since it is sometimes difficult to secure this line of traction in the ordinary position of the hands, it is often well, in the extraction of posterior positions, to place the left hand upon the shanks of the instrument near the vulva, and with that hand draw backward while the right hand steadies the extreme end of the handles.

It must not be forgotten that the maintenance of flexion and the consequent production of rotation are essential objects of this first application, since descent is dependent on them.

The production of forced rotation by a rotative movement of the handles of the forceps is so extremely dangerous to the soft parts of the mother as to be permissible to none but the most experienced operators. The operator who has really acquired sufficient skill to justify such a maneuvre will infallibly have acquired so active an impression of its dangers as to use it with the most

A B

FIG. 265.—Lateral motion of the handles of the curved forceps during the rotation of a posterior position of the head: A, position of the handles when first applied; B, position of the handles after partial rotation has occurred.

extreme care; but, though an active rotation force is not permissible, it is always proper, and indeed necessary to success, that the operator should avoid preventing rotation. He should know exactly the motion the handles will make during the rotation of the head, as that occurs under the guidance of the pelvic grooves, and he should be constantly on the watch to promote and favor this motion.

In this connection it must be remembered that when rotation occurs it will be in the axis of the blades and not in that of the handles, so that as the blades rotate their handles will move in a laterally circular direction such as is illustrated in Figure 265. If a good pair of straight forceps is at hand, it is much the better instrument for low operations in posterior positions, since with it no such lateral motion of the handles occurs, and the avoidance of the necessity of watching for it greatly simplifies the operation.

At the conclusion of each traction the handles of the forceps should be separated slightly, since, if this is done, the head not infrequently rotates to an anterior position within the blades. This manœuvre is especially useful when the original application of the forceps has been slightly inaccurate, and the head is, in consequence, not grasped exactly on its sides. A careful digital examination should always be made at the conclusion of each traction, in order to note exactly the mechanism which is going on, to become aware of rotation as soon as it occurs, and to detect any tendency to extension which may have followed a faulty application of the forceps.

As soon as the position is slightly anterior, or even when it becomes transverse, the forceps should be removed and reapplied to the sides of the head, but this time with the concavity of the pelvic curve toward the occiput, since any further rotation with the blades in the former position would carry them into the position of the reversed forceps, in which the grasp is unsatisfactory and the danger of laceration is great from the too close approach of the tips to the posterior wall of the vagina. The tractions should again be intermittent, rotation of the forceps with the head should be favored, and the compression should be intermitted during the intervals between the tractions, to permit the head to rotate within the blades. When the head has reached the O. D. A. position the forceps should again be removed, and reapplied in the ordinary way, unless the application is at that time wholly unsatisfactory. The operation as a whole is vastly more difficult than is an extraction in an anterior position.

Delivery in Persistently Posterior Positions.—When, from any cause, the proper maintenance of flexion has been neglected, and the occiput has settled into the hollow of the sacrum—that is, where it has become directly posterior —a delivery "face to pubes" is all that can be hoped for. Under these circumstances delivery by the natural efforts necessarily implies the presence of an unusually powerful and active uterus. It is necessary for the pains to force the head into extreme flexion, to mould it into a much-changed shape, and to distend the soft tissues to an extreme degree; and the *vis-a-tergo* of the uterus must usually be reinforced, before the process is completed, by the *vis-a-fronte* of the forceps.

The first duty of the obstetrician is to establish an extreme flexion by pressure on the forehead with the fingers; it will then be maintained by nature if the uterus is powerful enough to effect an unaided delivery. In this case an attempt to preserve the perineum by keeping the occiput well forward against the pubes is his only other duty; and as the necessary change in the shape of the head is to be most safely effected by slow moulding—that is, during a long second stage—he should be patient and loath to interfere; indeed, in these cases the use of the forceps is never warranted unless the signs of exhaustion of one or the other patient are clearly present and increasing and progress has ceased.

If the *forceps* must be used, it should be applied to the sides of the head, and the extraction should be effected by means of the so-called "pump-handle traction." The tractions should at first be directed well backward until the perineum distends, in order to draw the occiput downward along the posterior pelvic wall, and then should sweep forward, in order to draw it forward over the pelvic floor to the vulva and the arch of the pubes. These tractions should be gentle and intermittent, in order to encourage a slow moulding of the head,* and the forward direction should be maintained until the small fontanelle appears at the fourchette and the perineum retracts along the neck. The handles of the forceps should then be moved backward, but without intermission of the traction, in order to favor the appearance of the face from under the pubic arch by extension as in natural labor.

2. Face Presentations.

Frequency.—A face presentation is not a very common anomaly. Pinard found 320 face cases out of 81,711 deliveries at the Paris Maternité—a frequency of about 1 in 250. At Guy's Hospital Lying-in Charity, London, there was a freqnency of 1 in 276, or .36 per cent. out of 23,591 cases of labor. Churchill analyzed about 250,000 cases, and found that face presentations averaged 1 in 231. Collins at the Dublin Rotunda found the frequency to be 1 in 497. Spiegelberg thought that in Germany it was 1 in 324.

Relative Frequency of the Positions.—M. L. A. is but very slightly more frequent than M. D. P. M. D. A. and M. L. P. are very rarely seen.

Etiology.—Face presentations are, of course, produced by the extension of vertex presentations at or just before the beginning of labor, and every face presentation has therefore passed through the stage of brow before becoming a face presentation. Many factors may contribute to the production of this extension, and it is probable that the etiology of the anomaly varies widely in different cases. It may be originated by an *abnormal shape of the head,* by an *obliquity or abnormality of the uterus,* by *small tumors in or about the pelvic brim,* by a *deformity of the pelvis,* or by an over-tight adaptation between the head and the brim in a *posterior position of the vertex.*

Undue Length of the Hind-head.—Any abnormal prominence of the occiput necessarily lengthens the short arm of the cephalic lever, and therefore tends to the production of extension. The presence of such an anomaly would undoubtedly predispose to a face presentation, and cases have been reported in which it was apparently the sole cause; but in the majority of face cases the head is found to be of normal shape after the moulding of labor has passed away, and was therefore probably normal at the beginning of labor.

Obliquity or Abnormality of the Uterus..—An obliquity of the uterine axis by which the fundus is inclined to the side on which lies the back of the child tends to roll the condyles to the opposite side of the pelvis by altering the

* Since the chief danger in this operation is that of inhibiting the life of the fetus by compression of its skull against the pubes, it is well to have the fetal heart watched by an assistant, and to regulate the force of the tractions by the effect produced upon its beat.

direction of the uterine force (Fig. 266), in which the condyles are urged (in the direction of the arrow) by the uterus, and thus produces extension. Again, any irregularity in the contour of the uterine wall on the side to which the occiput is directed—for example, a cicatrix or a localized tonic constriction—may delay its progress and so produce extension.

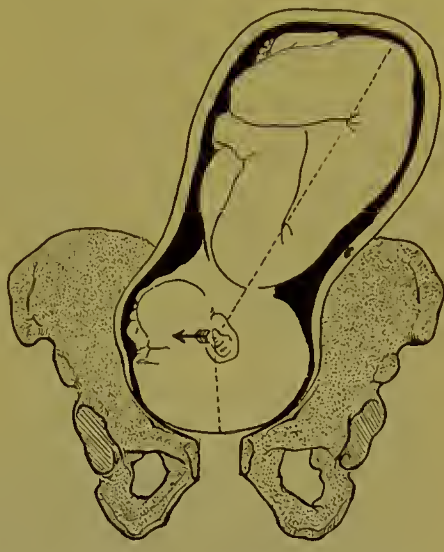


FIG. 266.—Manner in which an obliquity of the uterine axis may produce a face presentation.

Small Tumors in the Brim.—A tumor which impedes the advance of the occiput, but does not interfere with the sinciput, may be the cause of a face presentation.

Pelvic Deformities. — The minor grades of flattened pelvis in which moderate extension at the brim is normally present (see *Dystocia*) are a frequent cause of face presentations.

Tight Adaptation in the Posterior Positions of Vertex Presentations.—We have seen (p. 443) that there is a marked tendency to the production of extension at the brim in O. D. P. and O. L. P. positions. That this is a frequent cause of face presentation is shown by the fact that, although an O. D. P. occurs but about once in every four vertex labors, the results of its extension—that is, an M. L. A.—make up nearly one-half of all face labors.

Diagnosis.—On *abdominal examination* the fetal limbs, the heart,* and the least accessible portion of the head are found on the same side. On *vaginal examination* with the finger, the pointed chin, the mouth with its maxillary processes and the tongue, the nostrils, the bridge of the nose, the eyes, and the supraorbital ridges should be found and recognized. The position is determined by the position of the chin.

Prognosis.—The prognosis in face presentations for both mother and child is always somewhat worse than in vertex labor, but it varies greatly in accordance with the position of the chin, the prognosis of anterior positions being vastly better than that of posterior positions. The mortality of face presentations varies also between extremely wide limits, in accordance with the variations in the adaptation between the head and the pelvis, and more especially with the degree of ossification of the fetal head.

When the chin is *anterior*, when the adaptation between the head and the pelvis is moderately easy, and the fetal head is so soft as to permit of an easy production of the necessary change of shape, face labor is apt to be rapid. The prognosis for the mother is then unaltered from that of good normal labor, and the prognosis for the child is but little worse; but this statement is true only when the conditions are such that there is rapid progress throughout the

* In face presentations the heart is heard over the ventral side of the chest.

second stage: with the supervention of any delay the prognosis for the child becomes decidedly poor, while at the same time the mother's prospects are rendered less good by the risks of laceration during rotation that are always involved in a difficult or operative delivery of the face.

In *posterior* positions of the chin the prognosis for the child is always poor, since under the most favorable circumstances it is necessarily exposed to the utmost danger, both from the marked compression of the cranium against the symphysis that invariably occurs and from the great tension upon the tissues of the neck that is implied in the extreme extension necessary to excite rotation in posterior positions of the face. With any but the most extremely favorable conditions the prognosis for the child in posterior positions of the face is almost necessarily fatal, while that for the mother is complicated by the probability of extensive lacerations. In the large majority of such cases rotation fails, and the child's case is then practically hopeless, since no instance has yet been recorded in which the child's life was preserved during the extraction of a persistently posterior position of the face.

Mechanism and Management of Face Presentations.

Mechanism of Face Presentations.—In the mechanism of face presentations the chin plays the same *rôle* that the occiput does in vertex labor. Rotation is as necessary to expulsion in the one case as in the other, and the occurrence of rotation depends on the fact that under normal conditions the chin enters more deeply into the pelvis than the most prominent point upon the other side of the head, which in this case is that portion of the forehead immediately anterior to the bregma. This deeper entrance of the chin is in face presentation secured only by the existence of complete extension, and extension is therefore as important to progress during the second stage of face labor as is flexion during the second stage of vertex labor.

Fig. 267.—Presentation of the face at the pelvic brim.

Mechanism of Face Presentations, M. L. A.—Fully-developed face presentations at the beginning of labor are comparatively rare. The face commonly starts as a vertex, passes through the stage of a brow while still unengaged, and becomes a face presentation only during the passage of the brim. By reference to Figure 267, which represents the position of the head during the passage of the brim by a face presentation, it will be seen that after the point of the chin has passed the pelvic brim the ventral side of the head and the neck is so shaped as to offer but little opportunity for the engendering of friction against the pelvic wall, while the shape of the projecting forehead and bregmatic region is such as to ensure firm pressure between them and that part of the pelvis opposite. The position of the head brings its articulation with the spinal column far out to the

Fig. 268.—Face presentation at outlet after rotation (Smellie).

ventral side of the head, and we have then the pressure of the propelling force concentrated far out to one side in the head, while the resisting force of friction against the pelvic walls is exerted almost wholly upon the other side; hence good extension is the rule in face labor. The existence of complete extension,

Fig. 269.—Configuration of the fetal head after its delivery as a face presentation.

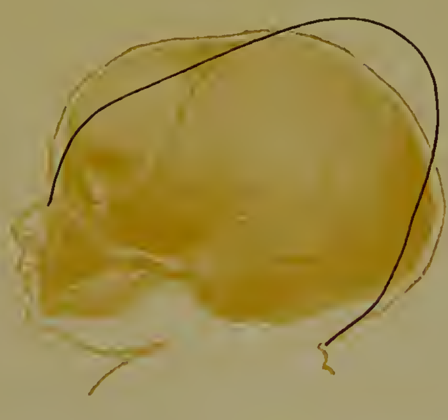


Fig. 270.—Configuration of the fetal head after its delivery as a vertex presentation.

however, places so great a strain upon the tissues of the neck that its production is usually accomplished slowly; and the diameter which must occupy the brim as the head descends—namely, the cervico-bregmatic (Fig. 267)—is so large that with reasonably tight adaptation the descent of the face is usually accomplished at the expense of considerable moulding of the head (Fig. 269).

The cervico-bregmatic diameter of the head is so far behind the leading point, the chin, that by the time the head is free from the superior strait—that is, when this great diameter passes it—the chin is already deep in the pelvis, and does, indeed, by this time occupy the deepest portion of the anterior groove of the left lateral wall. At this point there is often a temporary dead-lock, since the great elongation of the head may still leave the region of the sagittal suture in the sacro-iliac notch, where it is prevented by the promontory from turning backward, although the chin is being urged strongly forward by the lower portion of the anterior groove.

Rotation can then occur only when the propelling force is sufficiently strong to crowd the chin downward to the lowest possible point, and may even require a further lateral moulding of the head under the pressure of the promontory against the projecting occiput.

As soon as the occiput slips under the promontory rotation promptly occurs. The chin swings under the pubic arch (Fig. 268), and the mouth, the nose, the eyes, and the forehead successively appear at the fourchette. When the angle of the jaw rests against the descending rami of the pubes, the chin and the face become wholly freed from pressure, while the occiput is still exposed to the propelling power of the uterine force from above. The chin then sweeps upward, and as the occiput continues to progress, the bregma, the small fontanelle, and the occiput successively appear at the fourchette, and the head emerges by flexion.

The mechanism of face labor is, then, extension, descent, rotation, and birth by flexion. Restitution carries the chin to the side to which it was originally directed during the expulsion of the shoulders. The *mechanism of M. D. A.* labor is, of course, similar to that of M. L. A.

The Mechanism of Posterior Face Presentations, M. D. P.—The chin enters the posterior groove at the brim, and should travel forward along its course; but even when extension is complete the production of so extensive a rotation as is necessary to bring the chin to the front is rendered extremely difficult by the marked obstacle afforded to its performance by the resistance of the very prominent bregmatic region, which, notwithstanding its size (Fig. 271), must be made to travel backward along the whole left lateral surface of the brim—a motion possible only when the propelling forces are sufficiently powerful and the head is sufficiently soft to permit the production of a very extreme degree of moulding of the head. When rotation has once carried the chin into an anterior position, the mechanism, of course, is that of a primary M. D. A. No separate description of the M. L. P. mechanism need be given.

Management of Face Presentations.—*Management of Face Presentations at the Brim.*—The measures which must be considered in the management of face presentations when detected while the child is still in or above the brim are as follows: The case may be left to *nature;* an attempt may be made to raise the chin, and so restore a vertex presentation by *manual flexion of the head*, after which it may be left to nature or be delivered by the forceps; *forceps* may be applied *to the face* as such, or the case may at once be delivered by *version*.

Natural Labor.—The first expedient, that of leaving the case to the care of nature, is applicable only under one set of circumstances. When the chin

FIG. 271.—Posterior position of the face deeply engaged in the pelvis (Smellie).

is anterior; when the woman is a multipara who has had a succession of easy labors; if the accoucheur is able to satisfy himself by a thorough examination that the soft parts are soft and dilatable, that the pelvis is ample, and that the child is small, the latter point having been determined not only by palpation of the abdomen, but also by palpation of the head with the half hand introduced into the vagina; when the uterus is powerful and the pains are frequent; and, finally, when no pathological complication is present,—it is often wise to adopt a conservative policy; but the consequences of delay are so serious even in anterior positions of the face, and the prediction of an easy labor is always so difficult, that the obstetrician should feel that in making this prediction and adopting a policy of inaction he is taking a very grave responsibility. When the chin is posterior, or when, in anterior positions, the conditions are anything but the most favorable, it should be the rule that the detection of a face presentation at the brim is to be followed by immediate interference.

Interference at the Brim.—The choice of methods rests between *manual flexion of the head* into a vertex presentation, *version*, and the application of *forceps to the face*.

The choice between version and the production of a head presentation by manual flexion rests mainly on the position of the chin. If the chin is posterior, flexion of the head will result in the production of an anterior position of the vertex—the most favorable position for a subsequent delivery by nature or for an extraction by the forceps; if the chin is anterior, flexion can produce only the unfavorable posterior position of the vertex.

In posterior positions of the chin manual flexion should ordinarily be the first expedient, and the head, when flexed, should be urged into the brim by external pressure with the hand, in the hope that it may become engaged in this position under the influence of the pains, after which the case should, of course, be left to nature; but if an engagement does not follow promptly, it is best to apply forceps at once, since the conditions which originally produced the face presentation may usually be relied upon to reproduce it. If the manual reproduction of a vertex presentation proves difficult or impossible, the attempt should be abandoned and version be performed.

If the chin is anterior, flexion of the head would result in the production of a posterior position of the vertex; and since, as has been seen, posterior positions of the vertex at the brim are usually best treated, when interference is necessary, by a resort to version, it follows that in anterior positions of the chin, when interference is necessary, a primary version is the operation of choice. When in such cases a version is contra-indicated, the choice lies between an application of the forceps to the face and a manual flexion into a posterior position of the vertex, to be followed by an attempt at a manual rotation of the occiput to the front and the application of forceps. If the conditions are such as to render this latter operation possible, it is generally preferable to the use of forceps to the face; but since the conditions which contra-indicate version very generally render manual rotation of the head difficult or impossible, it will sometimes be necessary to resort in such cases to the use of forceps to the face.

The use of forceps to the face at the brim is always a difficult operation. The delivery of the child through the brim without injury to either mother or child can be accomplished only by the utmost accuracy in the adjustment of the blades; and even in anterior positions the prognosis is serious. The use of forceps to the face high is, then, never permissible to any but a thoroughly skilled operator, and even in such hands it should be reserved for a last resort. In posterior positions the forceps is *never* permissible, and it should be forbidden both from its inherent difficulties and because success in the passage of the brim can only result in the production of that very dangerous condition, a posterior position of the face within the excavation.

Management of Face Presentations, Low.—Chin Anterior.—When a face presentation has been allowed to pass the brim or has not been discovered until it is within the excavation, its progress should be watched with great care, and the utmost pains must be taken to maintain complete extension throughout the second stage. A constant watch over the processes of nature must be maintained, since any considerable delay is attended by great danger to the life of the child, from the likelihood that an interruption of its cerebral circulation may occur as a result of the extreme tension necessarily put upon the vessels of the neck or of their compression against the sides of the pelvis.

It follows from these dangers that even moderate delay furnishes a sufficient indication for the use of low forceps in face presentations. Complete extension, as has been said, is of the utmost importance, and, fortunately, may easily be maintained by pressure with the fingers upon the under surface of the lower jaw. Should interference become necessary, it is absolutely important that the forceps should be applied to the sides of the cranium, and with the tips so far posterior as to be entirely clear of the neck. In anterior positions, if this necessity be borne in mind, the application of forceps is easy, and the extraction of the child ordinarily presents no great difficulties; but it must not be forgotten that pressure upon the tissues of the neck by the tips of the blades must almost invariably result in loss of the child.

Chin Posterior.—As has been said, the face should never be allowed to enter the pelvis chin posterior. If this abnormality is not discovered until it has occurred, the patient should at once be etherized, the hand be introduced, and the possibility of raising the head above the brim should be tested. If this is possible without grave risk to the mother, it should at once be done, and the face dealt with according to the principles already outlined for the operative treatment of the face high (p. 463).

If elevation of the head proves impossible, the obstetrician should content himself with the maintenance of extreme extension by traction upon the chin in combination with a constant attempt to promote rotation by drawing the chin forward with the fingers. This process should be persisted in so long as there is, in his judgment, any possibility of rotation. When this prospect becomes hopeless, forceps may be applied and an attempt be made to extract the face as a persistently posterior chin presentation.

Any attempt at rotation by the forceps must be forbidden, both because of the grave danger of provoking extensive lacerations of the mother that necessarily attends this maneuvre, and because any slipping of the blades upon the child or any oblique application of the forceps would necessarily involve compression of the vessels of the fetal neck, and therefore the loss of the fetus. A straight forceps should be used if it is at hand. It should be applied carefully to the sides of the head and with the tips well anterior, so that the grasp of the blades may be wholly upon the cranial vault. The tractions should be directed slightly backward until the perineum is thoroughly upon the stretch, then forward and upward until the chin emerges, and then well downward, that the occiput may emerge under the arch and the head be born by flexion. Since lacerations of the pelvic floor are inevitable in this operation, and since every possible advantage must be taken, the perineum should be incised by deep lateral incisions as a preliminary measure.

This process has not yet been successful in the extraction of a living child; but since it has never, so far as known, been adopted while the child was in good condition, and as it has several times succeeded in extracting dead but uninjured children, it deserves a more extended trial whenever a child in this position is still in fairly good condition. If the child's vitality is already seriously compromised, its chances of life are so small that the prospect of preserving the mother's soft tissues would, in the judgment of most obstetricians, justify the choice of craniotomy.*

3. Brow Presentations.

Frequency.—As face cases have usually, if not invariably, passed through the stage of brow in the process of their conversion from a vertex presentation, temporary presentations of the brow must be at least as frequent as those of the face; but if only those brow presentations which remain such until altered by the obstetrician are included in the list, the frequency becomes less—probably not more than 1 in 1500 labors.

Relative Frequency of the Positions.—Brow O. L. A. and brow O. D. P. are almost equally frequent. The others are much less common.

Etiology.—Brow presentations are due to the same causes that produce presentations of the face, but it is of course a fact that if the process of extension is arrested in the stage of brow, it implies a greater obstacle to the progress of the head than where nature is able to develop a face presentation.

Diagnosis.—On *abdominal examination* the two ends of the head are found at about the same level, and the heart is usually heard over the back. On *vaginal examination* the small fontanelle is found at one end of the field, the large fontanelle in its centre, and the supraorbital ridges on the other side.

Prognosis.—Since at term and with a normal head the spontaneous delivery of an unchanged brow presentation is possible only after a degree of prolongation of labor that is disapproved by modern obstetrics, the prognosis of persistent brow presentations for both mother and child is that of the operation chosen. It should be remembered, however, that when nature changes the brow to a face the prognosis becomes that of a face presentation.

Mechanism and Management of Brow Presentations.

Mechanism of Presentations of the Brow.—*Anterior Position of the Brow (that is, brow O. D. P. and brow O. L. P.).*—In the rare cases in which a presentation of the brow succeeds in entering the pelvis, this possibility is due to the fact that the moulding of the head has progressed until the occipito-mental diameter has become sufficiently small to pass the oblique at the brim, and this change is compensated for by a corresponding increase in the occipito-frontal diameter (Fig. 272). The increase in the length of this diameter necessarily carries the forehead much deeper into the pelvis than any other part of the

Fig. 272.—Configuration of the fetal head after its delivery as a brow presentation.

* Since the above was written the great success of symphysiotomy has led most obstetricians to believe that a division of the symphysis should precede all applications of the forceps to a persistently posterior position of the face.

head, so that in anterior positions of the brow the projecting forehead engages in the anterior groove of the lateral pelvic wall as soon as the brim has been passed, and reaches its deeper part by the time the occiput escapes from the sacro-iliac notch and enters the shallow upper part of the posterior groove of the opposite pelvic wall.

If the conditions are so exceptionally favorable as to permit of the expulsion of an unchanged brow presentation, the forehead moves forward along the course of the anterior groove, while the occiput, being still in the shallow upper part of the posterior groove of the opposite side, moves back into the hollow of the sacrum; the root of the nose comes to the pubic arch, and the progress of the anterior portion of the head is then arrested, while the occiput travels down along the posterior wall of the pelvis and across the perineum. The nose and the chin then appear beneath the pubic arch, and the head in anterior positions of the brow is thus expelled by extension. External rotation, of course, carries the occiput to the side to which it was originally directed.

Posterior Positions of the Brow (that is, brow O. L. A. and brow O. D. A.).—Should an unchanged posterior position of the brow succeed in passing the brim, the forehead would enter the posterior groove and the occiput would lie against the shallow portion of the anterior groove. If the case went on to delivery, the rotation of the forehead along the posterior groove would be similar to that of the occiput in occipito-posterior positions of the vertex; but when the enormous difficulties incident to the expulsion of the brow under the most favorable circumstances are increased by the inherent difficulties always attached to rotation in posterior positions, the sum-total of the obstacle becomes so great that a delivery is almost unknown, and it may be laid down as a practical rule that posterior positions of the brow always become arrested.

Management of Brow Presentations: Management at the Brim.—When a brow presentation is detected at the brim, we may deal with it by any one of the four following methods: the case may be left to the care of nature; the brow may be converted into a vertex by manual flexion; the brow may be changed into a face by manual extension; or the case may be delivered by immediate version. The choice between these methods of treatment depends primarily on the position, but in posterior positions of the brow—that is, when the occiput is anterior—the indications are considerably modified by the presence of excessive moulding of the presenting part.

Anterior Positions of the Brow.—The class of cases which should be left to the care of nature is extremely limited, and includes only those few cases of anterior positions of the brow which, when detected, are rapidly changing into anterior positions of the face, and in which the conditions of the case are such that, if the face becomes established, its progress is certain to be rapid and easy. Flexion of such a brow would produce a posterior position of the vertex, and there is then but little hope of a spontaneous delivery of the new presentation, since the marked tendency to extension which always characterizes the posterior positions of the vertex would almost certainly reproduce the brow, while if an operative delivery is to be undertaken, version is the operation of election in posterior positions of the vertex. It follows that version is the operation of choice in anterior positions of the brow (see *Management of Face Presentations at the Brim*, p. 462).

All other anterior positions of the brow should be dealt with by immediate version as the operation of choice, the production of a vertex by manual flexion being ruled out for the following reasons:

In freeing a partially-engaged brow from the brim of the pelvis as a preliminary to version, it is essential that the first effort at raising the head should be directed against the forehead, since a preliminary flexion of the head replaces the long occipito-mental diameter by the shorter occipito-frontal diameter, and the subsequent elevation of the head therefore exposes the tissues of the mother to far less risk than would be involved in an attempt to force the extended occipito-mental diameter bodily upward. Moderate flexion is, moreover, an important element to success in the subsequent manipulations of the version, since its production minimizes the obstacle offered by the projecting sinciput.

When in anterior positions of the brow which promise a difficult delivery an attempt at version fails, a manual extension of the brow to an anterior position of the face, to be followed by forceps, is the only alternative to craniotomy, unless the condition of the child warrants a resort to one of the major cutting operations (see *The Use of Forceps to the Face at the Brim*, p. 464).

When the brow presents in a *posterior position*—that is, with the occiput anterior and with the head *unmoulded*—its treatment by manual flexion results in the production of an anterior position of the vertex, and a manual flexion is therefore in these cases the operation of choice. After the re-establishment of flexion the head should be held in position by the hands for a few pains; but, unless its engagement occurs promptly, it is usually best to resort to an immediate application of the forceps, since it may fairly be presumed that the conditions which originally led to the loss of flexion are still present, and will probably reproduce the extension if the case is left to itself. In this position of the brow a manual extension is contra-indicated, since it could only result in the production of a posterior variety of the face, which in itself is so dangerous that it demands an immediate version. If, therefore, in these cases a manual flexion is ruled out, version should again be selected as the operation of second choice.

When the brow presents in a *posterior position*—that is, with the occiput anterior and with the head already *much moulded*—the operation of manual restoration of the vertex must be ruled out in the interest of the child, for the following reasons: First, if a marked change of shape is apparent at the time the presentation is detected, the restoration of a vertex presentation by a manual flexion of the head presents great difficulty; moreover, the conditions are so much altered by the change in shape of the head that its re-extension into a brow would almost certainly occur as soon as the pains reappear or the forceps is applied. Second, a vertex delivery involves so extensive a re-moulding of the head to its original shape as to expose the child to great risk of danger from cerebral hemorrhage; while the delivery of a much-moulded brow by version—that is, by the extraction of the after-coming head—results in but little change in shape, and is therefore much the safer for the child. Version is, then, the only operation which should be considered in these cases.

The operative treatment of brow presentations, high, may be summarized as follows: In anterior positions, version is the operation of choice. In the posterior positions of unmoulded brows a manual flexion to an anterior position of the vertex and a subsequent application of forceps to the head should be preferred; this failing, version should be the second choice.* In the posterior positions of much-moulded heads version should be selected.

A high application of forceps to the brow is ordinarily more dangerous to the mother than a craniotomy, and but little more hopeful for the child. The abdominal operations would be indicated only in the interests of the child, and would usually be contra-indicated by the fact that the vitality of the child is usually considerably lowered by the time the ordinary operations have become impossible.

Management of Brow Presentations after their Entrance into the Pelvis.—Since the brow never enters the pelvis until after an excessive moulding has been produced, and since the adaptation is then always so close that any alteration of the presentation is impossible, it is unnecessary to discuss in this connection any other problem than the delivery of the brow as such excessively moulded and closely adapted to the pelvic cavity.

If the *sinciput* is *anterior*, the forceps should be applied to the sides of the head with the concavity of its pelvic curve anterior, and the mechanism of the natural delivery of a persistent brow should be imitated. The tractions should be directed downward and backward until the root of the nose engages at the arch, and their direction should then gradually be moved forward and upward until the occiput sweeps forward over the perineum, then downward again to permit the emergence of the face; but the chance of extracting a living child in this way is so small, and the risk to the mother's tissues is so extremely great, that the application is never permissible unless the child is in fairly good condition. If its vitality is already seriously lessened, it is probably the best practice to deliver by craniotomy. Such cases are, fortunately, almost never seen during the life of the child, and perhaps never at term.

If the brow has entered the pelvis with the *sinciput posterior*, and the child is still alive, a very cautious attempt to promote rotation by the forceps might be justifiable; but success would be extremely unlikely, and a resort to craniotomy would almost certainly be necessary. This condition, however, is so extremely rare that it is almost unnecessary to refer to it.

* An extension to a face and a subsequent rotation of the chin to the front are occasionally possible, but this operation is always difficult, and should not be attempted by operators of small experience.

4. Pelvic Presentations.

Pelvic presentations are commonly divided into breech, knee, and footling presentations; but knee and footling presentations are so similar in every respect to those of the whole breech that it is convenient to treat them as sub-variations.

Frequency.—Pelvic presentations occur in about 1 in 30 labors when miscarriages and premature labors are included. Among labors at term, however, their frequency falls to about 1 in 60 cases. Thus, Pinard found among 100,000 cases 3301 pelvic presentations, but on excluding the premature cases the proportion fell to 1 in 62. Among pelvic presentations about 60 per cent. are presentations of the breech.

Etiology.—Pelvic presentations are produced by the failure of the conditions which ordinarily ensure the existence of cephalic presentations (see p. 418). They are, then, especially frequent among premature and macerated children, when the liquor amnii is excessive and when the uterine and abdominal walls are very lax. They are the rule in hydrocephalus, and one out of every four twins is a breech child. In deformed pelves, too, in which the head is unlikely to become fixed at the inlet during the last weeks of pregnancy, breech presentations become more frequent. S. D. A. and S. L. P.—that is, the two positions in which the long diameter of the breech occupies the first oblique diameter of the inlet—are much more common than S. L. A. and S. D. P. Knee and footling presentations are probably always secondary, and are due to an active movement of the fetal limbs.

Diagnosis.—On *abdominal examination* the head is found at the fundus and its absence is noted at the brim; the heart is heard above the umbilicus. On *vaginal examination* in presentations of the breech the presenting part is at first high and is reached with difficulty. The finger recognizes the vulva or the scrotum and penis, as the case may be, the anus, and the sacral spines. On rectal examination of the fetus the coccyx, the tuberosities of the ilia, and the pubic arch are easily recognizable. The position is best determined by the position of the coccyx as ascertained by a rectal examination. In knee and footling cases the prolapsed extremity is recognized by its anatomical characters (see p. 415).

Prognosis.—The prognosis for the mother in breech presentations is only altered from the normal by the frequency with which rapid extractions are necessary, and by the fact that in such extractions there is a greatly increased risk of laceration. The prognosis for the child is always poor, the mortality running as high as 10 per cent. in skilled hands. The prognosis for both patients is worse when the mother's soft parts are rigid—for example, in primiparæ.

Mechanism and Management of Breech Presentations.

Mechanism of Breech Presentations.—*Normal Mechanism.*—In breech presentations the first stage is ordinarily abnormally slow. If the membranes are intact, the dilatation of the os is performed by them as in head presentations, and every care should be taken to preserve their integrity until the os is fully dilated. This precaution is of special importance in breech presentations, since, although the small and tapering breech is not ill-adapted to the dilatation of the os, the breech, when considered as a dilating wedge, labors under the disadvantage that its small size renders its passage through the cervix an inefficient preparation of the soft parts for the passage of the larger and harder head; extensive lacerations of the cervix are therefore frequent whenever the preparation of the cervix has been entrusted to the breech.

When the resistance of the cervix has been overcome, the comparatively small and soft breech naturally enters the pelvis easily, as the bitrochanteric diameter, the greatest diameter of the breech, is less than any of the diameters of the brim. The bitrochanteric diameter enters in one or the other oblique diameter, and is then crowded downward into the pelvis until the posterior hip impinges on the pelvic floor, when, under the forward shunt of this portion of the posterior wall of the pelvis, the breech as a whole bends forward by a lateral inflection of the trunk (Fig. 273). This movement engages the anterior hip in the deep portion of the anterior groove of that side of the pelvis to which it is directed, and as the anterior hip rotates forward the posterior hip slips back into the groove of the sacrum. The lateral inflection becomes well marked, the anterior buttock appears at the vulva, and as the trunk is driven more deeply into the pelvis by the uterine contractions the anterior hip becomes fixed at the pubic arch, and the posterior hip swings forward until the posterior buttock and trochanter appear successively from under the fourchette.

FIG. 273.—Lateral inflection of the trunk during expulsion of the breech.

As the posterior half of the breech emerges the perineum retracts upward along the child's pelvis, and, all pressure being thus removed from the posterior surface of the breech, the inflection is released and the trunk of the child is permitted to straighten itself again, thus releasing the anterior hip from its position of pressure against the pubic arch; the whole trunk then moves downward through the pelvis, and only such moderate lateral inflection as is necessary to accommodate the trunk to the course of the pelvic bones still persists. When the legs remain, as they should, in their normal position of flexion, the escape of the knees from the vulva releases the lower extremities.

At about the time the umbilicus appears at the vulva the shoulders enter the brim, their transverse axis lying in the oblique diameter. If the arms remain in their normal position—that is, crossed over the breast—the anterior shoulder rotates to the arch and is delayed by fixation against its inner surface, while the posterior shoulder and elbow pass the vulva. The escape of the posterior shoulder so diminishes the size of that portion of the body occupying the outlet as to permit the anterior shoulder to escape from the arch and emerge from beneath it.

The pressure of the uterus upon the longer arm of the cephalic lever should, under normal conditions, preserve the flexion of the head. In this condition the chin and the face necessarily enter the pelvis first, the suboccipito-frontal and suboccipito-bregmatic diameters occupying one of the oblique diameters of the superior strait. Since, at the time the head engages at the superior strait, the shoulders have already rotated into a position in which the bis-acromial diameter occupies the antero-posterior diameter of the outlet, the head approaches the superior strait in a transverse diameter, but the recession of the posterior portion of the lateral wall of the pelvis at the brim, as it approaches the sacro-iliac notch, causes the face and the forehead, the first portion of the head entering the pelvis, to swing backward into a posterior position. The after-coming head thus normally enters in an occipito-anterior position.

As the head enters the excavation the sinciput is so much lower in the pelvis than the occipital end of the head that it swings along the course of the posterior groove until it slips into the median line upon the pelvic floor, the occiput which is still exposed to the smooth bony surface of the brim at the same time rotating to the median line in front. The face appears followed by the forehead at the vulva, the perineum retracts over the bregmatic region, and the head is born, still in a state of flexion.

Abnormal Mechanism of Breech Presentations.—The frequent occurrence of abnormalities in breech presentations is to be accounted for by the ease with which the legs, the arms, and the head may become extended by friction against the pelvic wall. The descent of the legs and the arms should normally be accomplished *pari passu* with that of the body through the transmission of the uterine force to their upper surfaces by the liquor amnii; but in a large proportion of cases the cervix has still sufficient resiliency to contract tightly upon the fetal trunk after the legs have passed the cervix. The upper surface of the legs is then cut off from the pressure of the liquor amnii, while their descent is still opposed by an undiminished friction against the pelvic walls; again, they may be detained by being themselves caught in the grasp of the cervix, while the body continues to descend; or, finally, they may have been placed in an extended position by the action of their intrinsic muscles. As a result, it not infrequently occurs that the legs become extended against the body during the descent of the breech. Under these circumstances it occasionally happens that the legs are sufficiently closely applied to the child to act as rigid splints to its trunk, thus causing arrest by preventing the lateral inflection necessary to the passage of the trunk. An arrest due to this cause usually necessitates a resort to operative interference.

The re-contraction of the cervix upon the body may also result in an extension of the arms upward during the descent of the shoulders, until they lie along the sides of the head. The shoulders then enter the pelvis normally, but their further progress is arrested by the fact that, unless the child be small or the pelvis be unusually ample, the head and the arms form too bulky a mass to enter the pelvis together easily, and the interference of the obstetrician is again required. Even though the legs and the arms maintain their normal relations to the trunk, the passage of the head may be arrested by extension. Under normal circumstances the sinciput is driven into the pelvis, because the pressure of the liquor amnii upon the forehead is usually sufficient to overcome the resistance of the face against the pelvic walls, and there is nothing, therefore, to disturb the original relation of flexion of the head upon the chest; but if the attendant is injudicious enough to make traction, or if the already delivered portion of the trunk is unsupported, its weight, under the influence of gravity, is transmitted to the head through the occipito-atlantoid articulation, and a traction is thus initiated which is exerted solely against the occipital end of the head. The result is an abnormally rapid descent of the occiput. If this descent occurs before the head enters the superior strait, it may cause sufficient extension to result in the entrance of the occipito-mental or the occipito-frontal diameter into the superior strait, and thus produce an arrest of the head in this portion of the pelvis. If the influence of gravity only becomes active after the entrance of the forehead into the pelvis, no more than a partial extension is likely to result, but this partial extension brings the occiput into the deeper portion of the anterior groove of one lateral wall, while the sinciput rests in the posterior groove of the opposite wall. Rotation of the forehead forward is thus prevented, and there results a dead-lock which can only be broken up when a rapid descent of the forehead—that is, the restoration of flexion—is secured by operative influence.

Still another abnormality occasionally occurs. When the child is small or the pelvis is exceptionally ample—in other words, when the adaptation between the child and the pelvis is abnormally easy—the shoulders may enter the brim in the transverse diameter. If the back of the child is anterior, this produces no modification of the mechanism; the shoulders become oblique, and finally antero-posterior, during their passage through the lower part of the pelvis, the head enters with the sinciput posterior, and the birth goes on normally. If, however, the shoulders enter the superior strait transversely in a posterior position of the breech, the face and the forehead usually become engaged in the anterior portion of the pelvis before rotation of the shoulders can occur. If, under these circumstances, the flexion of the head is thoroughly well marked, the forehead passes along down the course of the anterior groove, the face appears under the arch while the neck retracts the perineum, and, if the pains are of the very best, the forehead may be urged down under the arch and the head be born in flexion.

The successful conduct of this form of mechanism by the forces of nature is, however, rare. It often happens that the projecting chin, the mouth, or the nose catches upon the upper border of the pubic bones. The sincipital end of the head is then delayed, extension results, the head jams across the brim by the occipito-mental or the occipito-frontal diameter, and an absolute arrest usually follows. Delivery by the efforts of nature then almost never occurs, and is only possible when the adaptation is so easy that the uterus is able to drive the occiput through the brim, while the chin slips upward and forward over the horizontal ramus of the pubes in order to make room for it. If this happy release of the chin happens, complete extension follows, the occiput appears under the fourchette, and the head is born in extension. This movement of extension is, however, usually accomplished only by traction on the body or by the application of the forceps; even then it is likely to involve so much delay that the preservation of the life of the child is unlikely.

Management of Breech Presentations.—Nothing more thoroughly tests the skill and judgment of the obstetrician than his management of a breech presentation. Upon the one hand, it is of the first importance that he should remain inactive so long as the natural processes are progressing satisfactorily. Upon the other hand, he must be prompt to foresee the appearance of danger to the child, and to interfere as soon as this danger is manifest. He cannot be warned too strongly to avoid premature interference, since the use of traction instantly disarranges the delicate balance by which the normal attitude of the child is maintained. As before stated, the maintenance of flexion in natural breech labor is due to the facts that the legs, arms, and forehead are driven down by the action of the intra-uterine-fluid pressure upon their upper surfaces, and that this pressure is more than sufficient to overcome the friction of the pelvic walls against the lower surfaces of these parts; but when traction is made upon the breech, the additional force thus supplied is distributed to the members only through the knees, the shoulders, and the occipito-atlantoid articulation respectively, while the very fact of its application—that is, the promotion of a more rapid descent—increases the force of friction exerted against the feet, the hands, and the forehead. Traction is then almost invariably followed by extension of the legs, the arms, and the head, with all its inherent difficulties.

When, however, interference is demanded, speed in extracting the arms and head is essential. After the scapulæ appear five minutes is an average time, within which the mouth should be brought to the vulva.

He who interferes in a breech delivery should feel that unless unusual good fortune attends his efforts he is likely to be confronted by the necessity of a manual delivery of each and every portion of the child's anatomy as these portions successively approach the pelvis. Even in the most skilled hands this process is attended by much more danger to the child than is involved in a natural delivery.

Since natural delivery is ordinarily possible only when complete flexion is maintained, since a single traction is likely to produce extension, and since, when extension has once occurred, delivery is ordinarily possible only by the immediate adoption and subsequent prosecution of an operative extraction, it becomes evident how important it is that the obstetrician should remain absolutely inactive unless there arise circumstances which show him that nature is likely to fail—that is, that the best chances for the child have been lost, and that the second best must be taken; for if it be true, upon the one hand, that a prompt natural delivery is safer for both mother and child than the best operative interference, it is equally true, upon the other hand, that when nature fails in promptness the only hope for the child and the best prospect for the mother is to be secured by the immediate performance of an operative delivery.

Management of Normal Breech Labor.—In breech labor the obstetrician's duty, so long as progress is normally rapid, is reduced to the following details:

It is wise never to conduct a breech labor without one skilled assistant, if such a person can be obtained. This assistant should give the ether if this is required, and should be ready to apply suprapubic pressure to the head if a rapid extraction becomes necessary. When delivery is imminent the woman should be placed in the lithotomy position, since there is never any certainty that interference may not become necessary at any moment. It is also well to put the patient slightly under the influence of ether as soon as the delivery is thought to be near at hand, since, if interference is indicated, it is rendered greatly easier by anesthesia, and because a partial anesthesia can be raised to the surgical degree with much less loss of time than is necessary to produce unconsciousness in a totally unetherized patient.

From the time the breech enters the pelvis the fetal heart should carefully be watched, since there is always danger of compression of the cord, and for this reason any irregularity of the fetal heart is sufficient cause for interference. As soon as the cord can be reached its pulsations will keep the obstetrician informed of the condition of the child.

As soon as the buttocks emerge from the vulva they should be wrapped in a warm sterilized cloth;* the attendant should do his utmost to relieve the perineum from undue strain by pressing the hips and the pelvis of the child into close contact with the arch; and even after the delivery of the hips he should continue to support the breech in an elevated position for the same reason. When the knees appear he should reduce the bulk of the presenting part by flexing out the legs. As soon as the umbilicus is within reach of the finger he should gently draw down a loop of the cord, to avoid the danger of undue tension upon the cord or upon the umbilicus during the subsequent descent of the body. The hips and the body should still be held constantly forward toward the mother's abdomen, in the curve of Carus, in order that the rotation and expulsion of the head may not be interfered with by the weight of the body; but no traction should be made during this process. As the elbows appear the forearms should be drawn out, and if the fetal body is sufficiently elevated the head should follow without delay.†

Rapid Extraction of the Breech when Arrested High.—When a breech is arrested at the superior strait until the signs of exhaustion of one or the other

* Warm in order to lessen the danger of a premature respiration, sterile on account of its contact with the vulva.

† For the procedure of extracting the head and arms low, see page 480.

patient appear, or when a rapid delivery becomes necessary by reason of some condition which threatens the life of mother or child, five methods of securing descent are applicable: Traction may be made upon the anterior groin with the *finger*, the *fillet*, or the *blunt hook; forceps* may be applied to the breech; or the hand may be inserted into the uterus, and be made to *bring down a leg* for use as a handle by which to make traction.

Of these methods, the use of finger in the groin is always preferable when its employment is possible, but in high arrest of the breech the finger seldom has sufficient power to secure descent; and if the breech is but slightly engaged in the brim at the time interference becomes necessary, the introduction of the hand to bring down a leg is ordinarily the method which should be chosen when the finger in the groin fails. If the breech is already so far engaged as to render this maneuvre difficult or dangerous, the cautious employment of the blunt hook or the fillet is permissible. An operator of practised skill may succeed by the forceps, but the application of this instrument to the breech at the superior strait is not to be recommended to beginners.

The Use of the Finger.—In applying this method the half hand should be passed into the vagina, the forefinger be hooked into the groin in any manner convenient to the operator, and traction be made downward and backward in the axis of the superior strait. Care should be taken to direct the line of traction rather toward that side of the pelvis to which the back of the child is directed, in order to lessen the danger of snapping the femur (Fig. 274).

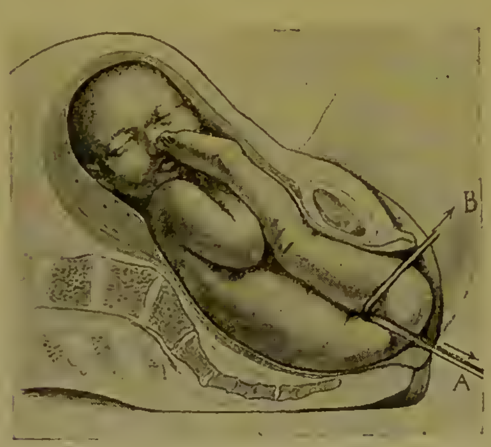


Fig. 274.—Proper (A) and improper (B) directions of traction upon the thigh.*

The Blunt Hook.—Both the fillet and the blunt hook can usually be applied to the groin, without special difficulty, in any portion of the pelvis, and both furnish fairly effective means of traction; both instruments, however, labor under the disadvantage of subjecting the tissues of the child to great risk of injury, the blunt hook, when skilfully used, being perhaps the less dangerous. The hook should be passed, under the guidance of the finger, between the anterior hip of the child and the pubic bones until it can be so rotated that its point passes between the child's thigh and abdomen. The finger should then be passed between the thighs and be brought into contact with the point of the hook, which should then be settled downward by gentle traction until its curve fits snugly into the flexure of the groin. The shank of the hook should then be grasped by the hand to which the finger belongs (Fig. 275), and traction should be made with the other hand, the finger lying in contact with the

* Though represented with the fillet, this Figure illustrates equally the manner of employing the fillet, the blunt hook, or the finger.

point of the hook throughout the extraction, in order to protect the soft parts from injury as far as possible. The line of traction should be directed toward the side on which the sacrum lies, in order to avoid fracture of the thigh.

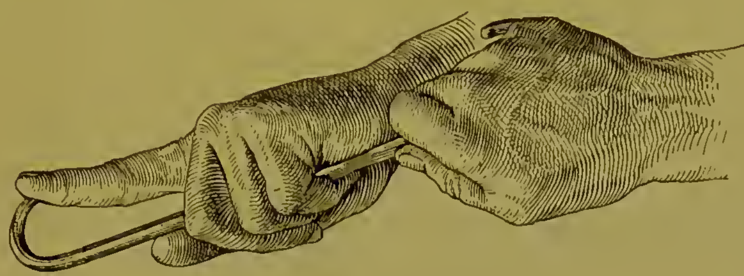


FIG. 275.—Method of grasping the blunt hook.

The Fillet.—The fillet may be made of a piece of broad tape, preferably linen on account of its greater strength, or of a wide strip torn from a silk handkerchief; the best fillet known, however, is that made by passing a stout cord through a piece of rubber tubing about three-eighths of an inch in diameter. The fillet may occasionally be passed through the groin by the unaided fingers, but in high arrest it is seldom possible to succeed in adjusting it by this method. Several instruments have been devised for the special purpose of placing the fillet, but their place can be filled equally well by a piece of string and a large English webbing catheter. The disinfected catheter should be threaded with a double loop of disinfected string or of narrow bobbin, and with its stilette, should then be bent to the shape of the blunt hook (Fig. 276). The catheter should be passed into the groin in the manner directed for the use of the blunt hook, and the finger should draw down the projecting loop of string until the end of the fillet can be passed through it, when, by the removal of the catheter, the fillet is placed in position in the groin. The same precaution as to the direction of the line of traction must be observed with the fillet as that recommended for the blunt hook and the finger.

FIG. 276.—Use of the catheter as a porte-fillet.

The Use of Forceps.—If the forceps is used in high arrest of the breech, its application is similar to that which is to be described under low arrest (p. 478), although it is much more difficult.

The Extraction of a Leg.—In the introduction of the hand into the uterus to bring down a leg, the breech should be pressed back gently through the brim before any attempt is made to pass the hand. The utmost gentleness should be observed throughout this manœuvre, and undue tension on the utero-vaginal attachments should be avoided by a careful maintenance of counter-pressure against the fundus with the other hand. The operator should always be careful to ascertain the position of the cord, to avoid the production of an unnecessary prolapse. If the foot is within reach, it should be seized and gently drawn out from the os. He should seize the anterior leg whenever that is accessible, as the line of traction on the anterior leg can be kept nearly in the axis of the inlet, while a pull on the rear leg brings the anterior buttock to a sitting position on the brim, and the traction in a line running from the child's hip, located near the mother's promontory through the vulva. If the legs are extended across the chest, two fingers should be placed along the crest of the tibia, and be used to so flex the leg that the foot passes down the median line of the child's abdomen until it reaches a position in which it can be seized and withdrawn.

When the foot appears at the vulva, the leg should be wrapped in a towel which has been dipped in a warm solution of corrosive sublimate, and traction should be made upon it in a line which should at first be directed as far backward as the perineum allows, in order to pull, so far as possible, in the axis of the superior strait. As the breech descends the line of traction should swing forward, until, when the hips clear the vulva, it is directed nearly vertically upward, the woman being in the lithotomy position. As soon as the knee is well outside the vulva the grasp should be shifted to the thigh, as any prolonged traction on the lower leg is apt to overstrain the ligaments of the knee-joint. If there is any difficulty in bringing the breech to the vulva, its delivery may be assisted by hooking the forefinger into the other groin as soon as it is within reach; as the breech distends the perineum it should be drawn well forward, and every effort should be made to prevent a laceration precisely as is done in the delivery of the fore-coming head.

When the second knee appears at the vulva, it should be drawn outward along the side of the child and toward its back, until the fingers can reach the leg and release the foot by flexion of the leg upon the thigh; but all pressure upon the shaft of the femur must carefully be avoided, since fracture of the femur during this process is always easy. Care should be taken to bend the knee only in the natural direction.

Rapid Extraction of the Breech when Arrested Low.—Low arrest of the breech can usually be overcome by the use of the *finger* in the groin, which method should always be the first tried. If this method fails, the use of the *fillet*, or, better, the *blunt hook*, is decidedly less dangerous to the child in low than in high arrest, the method of applying them being exactly the same; the *forceps* is here, however, easy and is almost invariably efficient; moreover, if due care is exercised, this instrument is far less likely to injure the child than is the blunt hook.

Application of the Forceps to the Breech Low.—If the breech lies in an antero-posterior or oblique position, the tip of one blade of the forceps should lie against the upper sacral vertebræ, while that of its fellow should be pressed into the flexor surface of the most easily accessible thigh (Fig. 277). If the position of the hips is transverse, each tip of the forceps should impinge upon a femur just above or beyond the trochanter, which then furnishes a firm hold for the blades (Fig. 278).

In making the application the forceps should be placed in an approximately correct position upon the breech, locked, and held lightly in this position. A hand should then be passed into the vagina until the finger-tips can touch the exact spots at which the tips of the blades should lie; an accurate adjustment is then easily attained by direct movements of the tips of the blades with the internal fingers. The small size of the tapering breech, in comparison with the diameters of any pelvis through which a living child can be extracted, renders it easy to obtain an accuracy in the adjustment of the forceps that is impossible of attainment when the forceps is used upon the head. It is this fact which renders the forceps valuable in this connection, since the avoidance of injury to the child and the attainment of a secure grasp of the breech are to be effected only by the adjustment of the tips to exactly the points to which they were directed, and the utmost care must be observed in verifying the position of the forceps before any traction is made. When the operator is sure that the instrument is satisfactorily in position, the handles should be grasped sufficiently tight to ensure a firm pressure, which should then be maintained without intermission until after the delivery of the child.

Fig. 277.—Forceps applied to an oblique position of the breech.

Fig. 278.—Forceps applied to a transverse position of the breech.

The ordinary forceps is better adapted to this application than any special forms which have yet been devised. When the instrument is used upon the high breech the advantages of axis-traction are perhaps more fully apparent than in any other obstetric operation.

Rapid Extraction of the Trunk.—As soon as the legs and the pelvis of the child have cleared the vulva, they should be grasped (through a warm aseptic towel) in the manner shown in Figure 279, in which each thigh is grasped by the fingers of one hand, the thumbs of the operator lying along the sacrum; this grasp should be maintained throughout the extraction, no other grasp being so secure, and any pressure upon the crests of the ilium or upon the abdomen of the child being dangerous to its bones and abdominal viscera. The line of traction should be directed as far backward as the perineum allows, in order to facilitate the passage of the shoulders through the superior strait, and the back of the child should be kept steadily directed upward—that is, toward the anterior portion of the mother's pelvis—to secure an anterior position of the occiput for the after-coming head. When the umbilicus appears at the vulva a loop of the cord should be drawn downward, as is done during the normal delivery of the breech.

FIG. 279.—Method of grasping the thighs during the extraction of the breech.

Rapid Extraction of the After-coming Head and Arms.—If, by any chance, either arm remains flexed upon the infant's chest, it may easily be drawn out when the elbow appears at the vulva; but in the great majority of cases both arms will be extended beside the head, and their extraction is then more difficult. The method that should be chosen for their release must depend upon the point of the pelvis at which the shoulders become arrested.

Low Arrest of the Arms and the Head.—In easy extractions it is very often possible to bring the shoulders into sight outside the vulva by simple traction upon the thighs. In such cases it is frequently possible to extract the after-coming head and arms by the very easy and simple maneuvre known as *Deventer's method.* In this procedure the body of the child is dropped downward as soon as the points of the shoulders are in sight; the feet are grasped with one hand, the fingers of the other hand being pressed upon the upper surface of the shoulders, and the child is drawn vertically downward toward the floor, the mother being in the lithotomy position. Under this traction the occiput appears at the vulva, and the forehead and face follow coincidently with the arms. The mechanism by which this somewhat surprising delivery is accomplished is as follows: The method is applicable only when the pelvic space permits the head and the arms to enter the brim together, and both are then contained in the excavation when the shoulders are at the vulva. The arms are then in contact with the elastic sacro-sciatic ligaments, which stretch before them and permit them to lie by the side of the head. The chin is arrested by the pelvic floor; the head extends, and thus brings the occiput to the vulva. The head is then delivered in extension, and the arms follow

(Fig. 280). The original advocates of this method claimed that it rarely if ever tears the perineum, and the writer's experience with it certainly supports this claim.

When the conditions permit the head and the arms to enter the pelvis together—that is, when the shoulders can be brought to the vulva by traction upon the thighs—Deventer's method, though not the most powerful, is certainly by far the most rapid and easy of all the maneuvres for the release of the head and the arms, and it should always be given a trial. It is necessarily inapplicable when the head and the arms are arrested at the superior strait. Traction then only increases the difficulty.

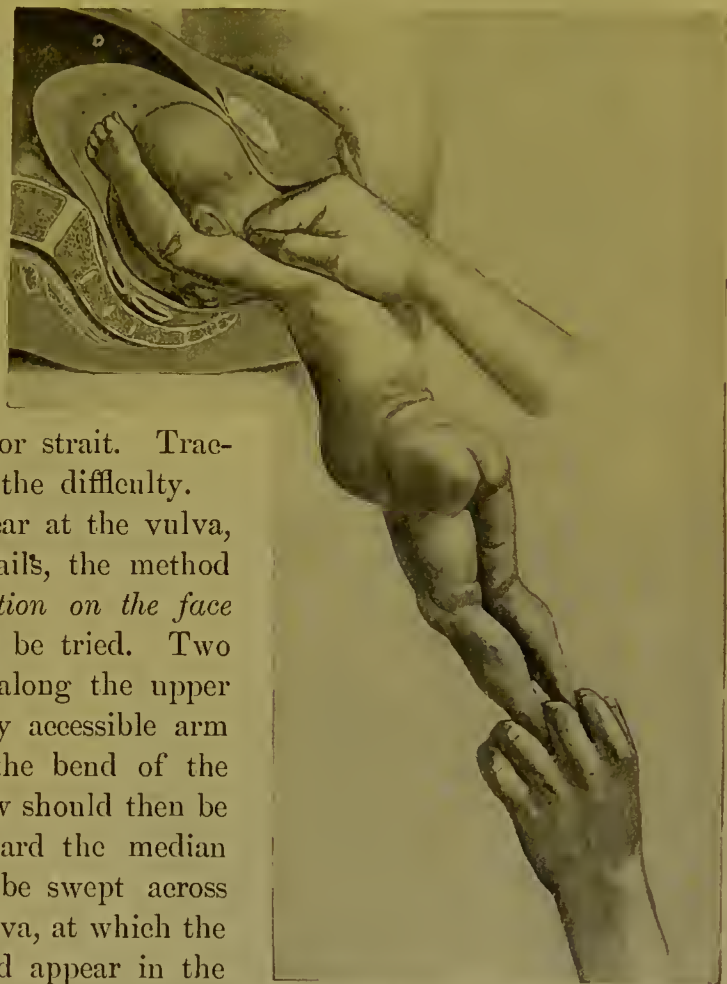


Fig. 280.—Deventer's method of extraction of the after-coming head and arms.

If the shoulders appear at the vulva, but Deventer's method fails, the method known as *combined traction on the face and the shoulders* should be tried. Two fingers should be passed along the upper surface of the most easily accessible arm until their tips rest in the bend of the child's elbow. The elbow should then be urged backward and toward the median line by the fingers, and be swept across the child's face to the vulva, at which the elbow, forearm, and hand appear in the order named. This process should then be repeated with the other arm. Pressure upon the shaft of the humerus should carefully be avoided, since it is certain to snap the bone. The child is then laid astride of one of the operator's fore-arms, and the hand belonging to this forearm is passed into the vagina until its first and second fingers lie upon the canine fossæ of the child. The other hand is hooked over the shoulders, the neck being between its first and second fingers, with the finger-tips upon the supraclavicular region (Fig. 281). The hand that is hooked about the shoulders is then used to make traction upon the child, while the internal hand exerts itself to preserve the flexion of the head. The direction of the first tractions should be in the line of the axis of that part of the pelvis in which the child lies, and as the head emerges the line of traction should sweep forward in the curve of Carus until, at the end of the extraction, the body of the child rests upon the other forearm and along the abdomen of the mother (Fig. 282). When the mouth appears at the vulva and the mouth and pharynx have been cleared out, all hurry ceases, and the

FIG. 281.—Delivery of the after-coming head by combined traction on the head and shoulders.

operator's efforts should be directed to the preservation of the perineum. But little traction should now be used, and the hand that was applied to the face should be used to shell out the head by pressure on the forehead through the perineum, or, if necessary, by passing two fingers into the rectum.

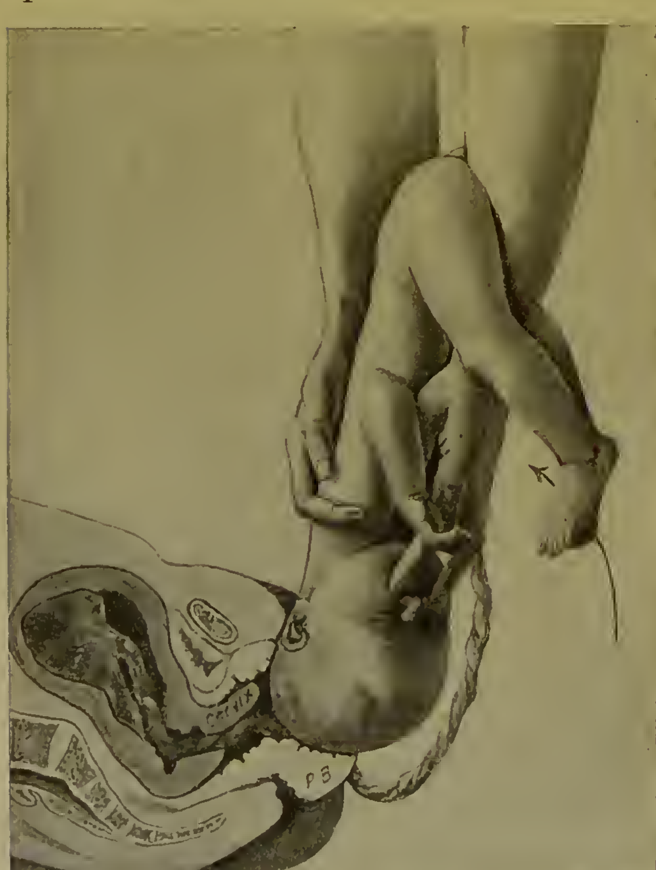


FIG. 282.—Position of the child immediately after the escape of the after-coming head from the vulva.

High Arrest of the Arms and Head.—When the adaptation between the head and the pelvis is not sufficiently easy to permit the simultaneous entrance of the head and the arms into the pelvis, the arrest of the shoulders at the superior strait may be known by the fact that the child ceases to make progress, under tractions of ordinary strength, at about the time when the tips of the scapulæ appear at the vulva. At this point of the extraction it is therefore important to watch for a marked increase of resistance, and when this is observed the tractions should immediately be intermitted, since their continuance only serves to lock the head and the arms securely in the brim, thus rendering the subsequent maneuvres for their release more difficult.

The body of the child, in such an event, should be pressed slightly upward, and be rotated until the back is directed to one or the other side of the mother's pelvis. The hips should then be elevated gently toward the mother's abdomen and toward the side to which the back of the child is directed, moderate traction being exerted upon them at the same time. The object of this maneuvre is twofold: first, that space may be afforded for the passage of the hand into the vulva along the abdomen of the child; secondly, that the posterior shoulder, which is usually the most accessible, may be brought as deeply into the pelvis as possible.

The hand of the operator that naturally faces the abdomen of the child should then be passed rapidly into the vulva, with its palm flat against the abdomen and chest, until two fingers can be passed up along the arm of the child and their tips placed in position in the bend of the elbow. No pressure upon the arm should be made until this position is reached, but when it is attained the elbow should be drawn down across the child's face until the forearm and hand are within easy reach and can be brought to the vulva.

If the hand passed along the abdomen fails to reach the elbow, the latter may sometimes be found by seizing the feet in that hand and drawing them gently upward and to the opposite side, so that the hand which before held the feet can be passed along the back of the child close under the pubic arch to the back of the posterior shoulder, and thence along the arm to the elbow, which, however, must, as before, be brought downward across the child's face.

The hips of the child should then be swept downward and traction be made upon the thighs, in the hope that the pelvic space may permit the entrance of the head with the remaining arm; if this does not occur, the body of the child should again be pressed backward into the pelvis, and the child be so rotated that the arm which was anterior becomes posterior, when it should be released by the same method that was used in the extraction of the first arm. During this rotation the back of the child should sweep across the front of the mother's pelvis. This rotation may be effected either by grasping and turning the thorax with both hands or by drawing the already extracted arm forward along the side of the pelvis, between the labium and the back of the child.

In rotating the child it must always be remembered that the articulations of the neck are so arranged that if the point of the chin be carried beyond the point of the shoulder a dislocation of the atlas upon the axis is the result. For this reason the thorax should be pushed strongly upward whenever an attempt at rotation is made, in order to free the head from the superior strait; and the hands of the assistant should watch the head from above, that he may warn the operator if it fails to follow the shoulders. In the extraction of the head from the superior strait the method of combined traction upon face and shoulders is usually the best, but it should then be reinforced by suprapubic pressure applied in the axis of the brim by the hands of an assistant.

Difficult Extraction of the Head and the Arms.—Arrest of an Arm behind the Occiput.—It sometimes happens that the head rotates with the shoulders, but the arm is detained behind the pubes by friction against its walls. In such a case the arm crosses the nape of the neck and, if traction is made, becomes jammed between the occiput and the symphysis. If this accident is discovered before traction has been made, prompt rotation in the reverse direction may unlock the arm, and in this case this reversed rotation should be continued until the arm becomes posterior—that is, through 180°; but unless the first attempt unlocks the jam, the child will probably be lost, and it is then, perhaps, best to make direct traction upon the arm at the risk of fracturing the humerus, after forewarning those present that this must be the result, and that it is done in the interests of the child.

Closure of a Constriction-ring, or of an Imperfectly dilated Os, about the Neck.—The stricture of the canal formed by either of these conditions may embarrass the release of the arms, but it does not otherwise affect the above-described maneuvre, except that any abrupt or too forcible movements of the hand while within the uterus are even more dangerous in these cases than in others. The extraction of the head from the constricting band is, however, often a matter of great difficulty. Any attempt to overcome this obstruction by force exposes the mother to the most imminent danger of rupture of the uterus; and though steady traction upon the mouth and the shoulders should be given a fair trial, and may effect dilatation in time to save the child, it is in these cases that the application of forceps to the after-coming head is most often indicated. There can be no doubt of the truth of Lusk's observation, that "the forceps will sometimes bring the head rapidly through the cervix when traction upon the feet only serves to drag the uterus to the vulva." Care should be taken, however, that this rapidity be not so great as in itself to cause a serious laceration.

Arrest of the Head at the Superior Strait by reason of an Unusual Size of the Head.—Most German and American obstetricians believe that the use of combined traction upon the face and the shoulders is the best method to adopt in arrest of the after-coming head at any point in the pelvis, and it should certainly be the first method tried in any given case; but as cases frequently occur in which the head can be delivered with far greater ease by a rapid alternation between two or more methods than by the continued use of any one alone, it is for this reason, if for no other, well to be familiar with all the methods which have been found of value.

The Prague Method.—This maneuvre is often of service in effecting the engagement of the head and its initial descent into the superior strait. This is especially true in certain forms of contracted pelvis and with operators whose muscular strength is inadequate to the really severe strain which is sometimes imposed upon the internal hand in the use of the combined method at the brim, but it is usually inferior to the combined method after the greatest diameter of the head has passed the superior strait. Like all methods of manual extraction, it is greatly increased in value by the application of proper suprapubic pressure by an assistant.

In executing the Prague method the feet are seized by one hand and the body is drawn as far downward as the perineum allows; the other hand is

FIG. 283.—Delivery of the after-coming head by flexion through seizure of lower jaw, and extrusion by means of pressure in axis of brim.

then hooked over the shoulders, and traction is made by both hands simultaneously (Fig. 284). As the head enters the excavation the body is swung rapidly upward, and the remainder of the delivery is accomplished by upward

FIG. 284.—Prague method of extracting the after-coming head, superior strait.

traction on the feet, while the hand upon the neck promotes flexion by retarding the descent of the occiput (Fig. 285). The chief disadvantage of the Prague method lies in the fact that all the force exerted by the operator is expended upon the child's neck, and that the amount of force that can safely be applied is therefore less than in the combined method.

Arrest from Extension of the Head.—This condition is rare unless in improperly conducted extractions, but if, by any clumsiness on the part of the operator, the abdomen of the child has been directed to the front during the liberation of the arms, and the chin is therefore arrested at the symphysis, the Prague method should be used throughout. In this case the direction of the first traction should be nearly horizontal (Fig. 286), and as the occiput descends the body of the child should be raised until, when the head emerges from the vulva, the line of traction is nearly parallel with the mother's abdomen.*

FIG. 285.—Prague method of extracting the after-coming head, inferior strait.

Forceps to the After-coming Head at the Superior Strait.—The use of the forceps is generally believed to be the most powerful and certain means of overcoming difficult cases of high arrest of the after-coming head. This operation is, however, often difficult, and the time occupied in the application of the forceps may be of vital importance to the child. Moreover, there are but few cases in which a skilled operator, aided by efficient suprapubic pressure, fails to deliver by manual extraction; but as such cases do occasionally occur, the forceps should always be at hand before the delivery is attempted. If

FIG. 286.—Extraction of after-coming head, chin arrested at symphysis.

forceps be used, the body should be raised to a nearly vertical position, and the

* If forceps is necessary, the instrument should be applied under the child's body, and should extract by the same mechanism.

forceps should be passed into place upon the sides of the head, beneath the abdomen of the child. An axis-traction model should be preferred.

Arrest of the Head at the Inferior Strait or on the Perineum.—Cases in which manual extraction by the combined method fails to overcome a low arrest are extremely rare, but if forceps be required the application and extraction are always easy.

Arrest of the Head due to Contraction of the Pelvis.—In the ordinary form of contraction the arrest is always at the brim, and after the head has passed the superior strait the subsequent delivery is easy.

A breech presentation should never be allowed to persist as such in a *justo-minor pelvis,* but if it has not been corrected the inevitable arrest of the head at the superior strait should be met by extreme flexion and by the application of forceps, followed by craniotomy if not promptly successful.

In all *flat pelves,* and in flat pelves only, the head enters the superior strait in the transverse diameter, and the passage of the strait is most easily effected in a somewhat extended position, in which the biparietal diameter is received by one of the sacro-iliac notches, while the lesser bimastoid diameter is opposed to the contracted conjugate: if, then, the hand, when it is passed into the vagina for combined traction, finds the head transverse, it should allow extension to go on until the face begins to approach the side wall of the pelvis or until the greatest diameter of the head has passed the superior strait; when this has occurred flexion should promptly be restored, and rotation and delivery will then rapidly follow.

In *simple flat pelves* the application of forceps to the after-coming head is rarely successful after manual extraction has failed, but in pelves of the *generally-contracted flat* type, if the transverse diameter is markedly diminished, the mechanism approaches that of a normal or justo-minor pelvis, and if the breech presents and efforts at manual extraction of the head fail, the application of the forceps may be tried.

5. Footling Presentations.

Mechanism and Management.—The mechanism of footling presentations is in no way different from that of presentations of the whole breech. The treatment varies only in that in a rapid extraction there can be no question as to the choice of operation.

6. Transverse Presentations.

Under transverse presentations are included presentations of any portion of the trunk; but as all transverse presentations soon change to presentations of the shoulder, it is only necessary to speak of the latter.

Frequency.—Transverse presentations occur in from 1 in 150 to 1 in 300 of all cases of labor. Thus, Spiegelberg made the proportion 1 in 180; Churchill, 1 in 252; and the Guy's Hospital Reports, 1 in 297 (or .32 per cent. out of 22,980 cases of labor). The positions are of but little importance.

Etiology.—Transverse and breech presentations are produced by the same causes (see p. 470), but in transverse presentations the influence of pelvic deformities is somewhat more important, since, if the head cannot enter the brim, it may slip to one side and permit the shoulder to enter even after labor is well under way.

Diagnosis.—On *abdominal examination* the longest diameter of the uterus is transverse; the head is found in one flank, and the breech in the other. On *vaginal examination* the finger may be able to recognize the clavicle and the spinous process of the scapula, and to ascertain that there is but one limb attached to the presenting part, but the vaginal diagnosis is apt to be obscure unless an arm is prolapsed.

Prognosis.—As the termination of a transverse presentation by natural labor is extremely rare, the prognosis for both mother and child is necessarily that of the operation undertaken. When the abnormality is detected and treated early, the prognosis for both patients should be fairly good, but it becomes worse in proportion to the length of time during which the case is allowed to go on untreated.

Mechanism and Management of Transverse Presentations.

Mechanism of Transverse Presentations.—Since natural delivery so rarely occurs in transverse presentations, the later stages of the mechanism by which it is effected are of small practical importance; but, notwithstanding the rarity of its completion, its earlier stages are rendered not unimportant by the fact that success in the delivery of impacted shoulders rests upon a thorough comprehension of the processes by which the impaction was effected, this being, in fact, the first stage of the mechanism of natural delivery in transverse presentations. The process is commonly known as the "spontaneous evolution of the fetus." Any part of the trunk may present at the beginning of labor; but as the fetus is crowded down into the brim, the shoulder inevitably enters deepest in persistent transverse presentations, and, since the shoulder always becomes anterior early in labor, it is only necessary to describe the anterior form.

In the anterior form the supraclavicular region corresponds, at the time of the entrance of the shoulder, with the anterior end of one oblique diameter at the brim, the lower portion of the thorax lying at the posterior end of the same oblique diameter. The full width of the shoulder enters the pelvis, and this portion of the child is then fixed in position by contact of the neck with the horizontal ramus of the pubes. Under the influence of the driving power of the uterus above, the lower portion of the thorax is forced more and more deeply into the posterior half of the pelvis by a lateral inflection of the body of the child upon itself. The trunk then dips into the excavation, the true ribs, false ribs, abdomen, and pelvis of the fetus entering in the order named (Fig. 287). If the child is sufficiently flexible and if the uterus is sufficiently powerful to complete the delivery, this process of lateral inflection of the trunk goes on until the pelvis of the child appears at the vulva, and with its expulsion the case is converted by spontaneous evolution into a presentation, or rather an expulsion, of the breech, in which, however, one shoulder is already within the pelvis and one arm is already delivered.

A second and very much more rare form of delivery in persistent transverse presentations is seen only with immature fetuses, and it can seldom occur unless maceration is far advanced. In it the prolapsed shoulder is driven forward through the pelvis, the head of the child being crowded into the pelvis with the body (Fig. 288). The shoulder is the leading point, and it should

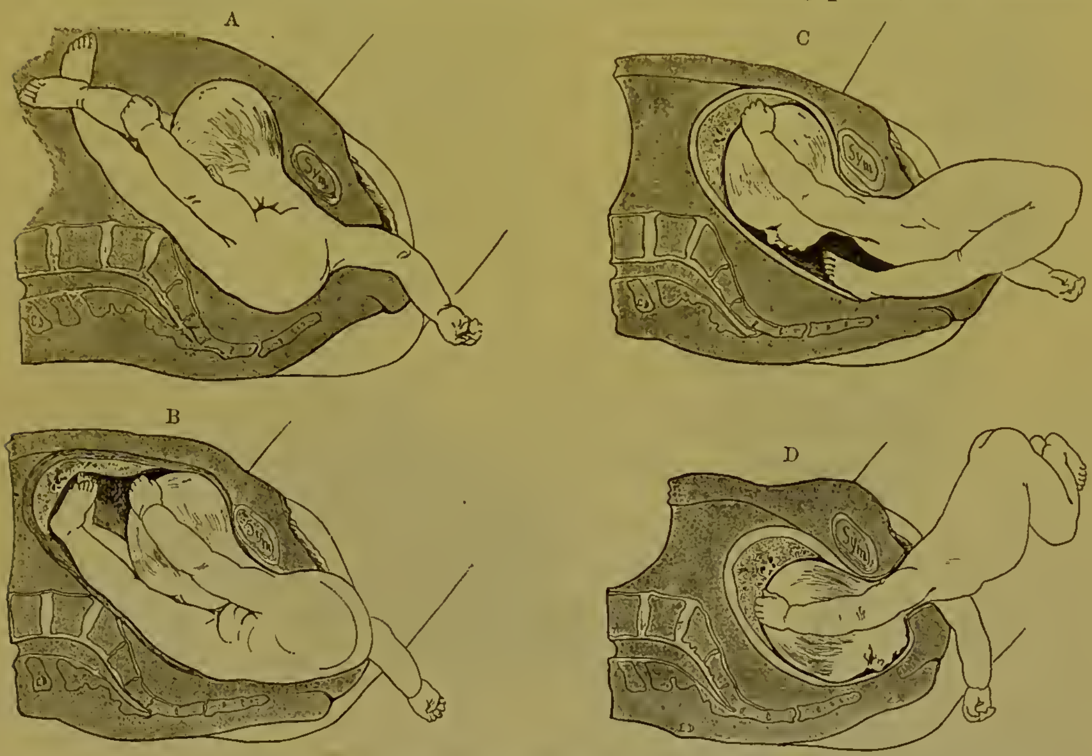


Fig. 287.—Spontaneous evolution, first form of mechanism.

rotate to the arch, but when this process is possible the body is always so small and soft that the mechanism is usually but little marked.

Management of Transverse Presentations.—The prognosis of spontaneous evolution is so bad for both child and mother that transverse presentations should never be left to nature, and the question of the treatment is simply the question of the choice of the operation to be adopted. Three operations are applicable to the treatment of transverse presentations in its various stages—the several varieties of *version, decapitation,* and *exenteration,* the choice between them depending upon the stage of labor at which the presentation is detected.

Version.—If the presentation is detected before any portion of the trunk is deeply engaged, and while the membranes are still unruptured, one or the other of the *external versions* should be chosen. If the abdomen or the hip presents, pelvic version will usually be the easiest, and for this reason should generally be preferred; if the conditions are such as to render cephalic version easy and if the pelvis is normal, cephalic version should be performed.

If the shoulder presents, cephalic version should be chosen, except in a flat pelvis, where the shape of the inlet makes a breech presentation the presentation of choice. In such cases an external pelvic version would naturally be chosen. If, at the time an operation is undertaken, the shoulder has already entered the pelvis, but the conditions of the case are still such as to permit of version, a *bipolar, cephalic, or pelvic version* should be performed.

If, at the time when interference is decided upon, the membranes are already ruptured, and especially if the shoulder is already well crowded into the pelvis, the external and bipolar methods will usually be impossible, and internal podalic version must be chosen.

Internal Podalic Version in Transverse Presentations. — This operation differs from internal version in head presentations only in the choice and method of introducing the hand, in the frequent occurrence of a prolapsed arm, and in the method of raising an impacted shoulder.

FIG. 288.—Spontaneous evolution, second and rare form of mechanism, known as birth with double body (one-sixth natural size, redrawn from Küstner).

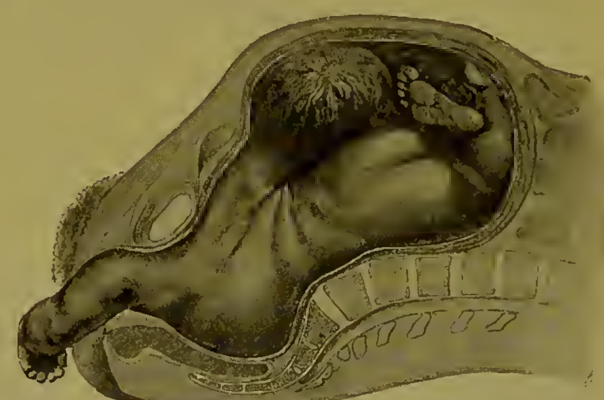


FIG. 289.—Frozen section of shoulder presentation (Chiara): the distortion and the elongation of the neck are noteworthy.

In raising the shoulder it is necessary to remember the mechanism of the method by which nature deals with a neglected transverse presentation—that of spontaneous evolution. In this process, as has been said, the trunk enters the pelvis at the brim in an oblique diameter, but as it is forced farther down the shoulder rotates to the front and becomes fixed there, while the thorax and the abdomen are crowded into the posterior portion of the pelvis by flexion upon themselves (Fig. 287). Now, so long as the position is still oblique, and if flexion of the trunk has not begun, the presenting part may easily be raised by pressure upon the shoulder in the axis of the superior strait; but so soon as the shoulder has rotated to the front and the thorax has entered the pelvis, it is essential that the process of relieving the impaction should begin by the return of the part which entered last—that is, of that portion of the thorax and the abdomen still lying opposite the sacro-iliac synchondrosis. No pressure must be exerted upon the shoulder itself until the trunk again occupies an oblique position. It will be seen that the process of unlocking the impaction is by a direct reversal of the mechanism of spontaneous evolution. Of course, during this whole process the most careful counter-pressure must be maintained at the fundus.

In simple cases a prolapsed arm may be used as a convenient handle by which to push up the shoulder, and in all cases it is well to begin the opera-

FIG. 290.—Direct method of seizing a foot in version for transverse presentations.

FIG. 291.—Direct method of seizing a foot in version for transverse presentations.

tion by noosing a fillet around the prolapsed wrist. This fillet answers a double purpose: First, it may be used to draw the arm out of the way of the operating hand; second, during the process of extraction slight tractions on the fillet will prevent the extension of that arm, thus greatly facilitating the delivery; but care must be taken to remove the noose as soon as possible, for cases are on record in which sloughing of a member has followed the too prolonged or violent use of a fillet.

FIG. 292.—Method of reaching the foot by first passing the hand around the breech.

In the search for a foot two methods may be used: The hand that corresponds with the position—that is, left position, left hand—may be passed along the back and over the buttocks to the thigh and leg (Fig. 292), or the hand may be passed across the abdomen and directly to the feet (Figs. 290, 291). The first, which is the surer way, should, as a rule, be preferred, but the latter method is often the easier, especially in abdomino-anterior positions. Much has been written on the advantage to be gained by selecting the superior foot in version for transverse presentation; but as this view has never obtained much credence outside of England, and as Galabin, one of the latest British authorities, not only disapproves of this practice, but gives a very convincing mechanical proof of the fallacy of the theory which prompted it, the subject need only be mentioned here. Unless special care be taken to select the superior foot, the lower foot is almost invariably seized.

Treatment of Neglected Transverse Presentations.—When a transverse presentation has been so long neglected that the release of the shoulder is thought to involve more danger to the mother than it would be justifiable to incur in the interests of the child, or when the child is already moribund or dead, one or the other of the appropriate destructive operations must be undertaken.

If the neck is at this time within reach, *decapitation* should be selected. If the process of spontaneous evolution has gone so far that it would be difficult or impossible to apply the decapitator to the neck, an *exenteration* should be chosen, and after the abdomen and the thorax have been emptied of their contents the operator must use his judgment as to whether it is safer to break the vertebral column and extract the child still doubled up upon itself, or to draw the fetal pelvis into that of the mother by traction with the fingers from within its cavity.

7. Prolapsed Extremities.

Presentation of the Head and a Hand.—When a hand prolapses and enters the pelvis with the head, it is most commonly placed at one end of the bitemporal diameter. Its presence then generally results in delay through the increased size of the presenting part, and it may occasionally interfere with rotation. If the hand is placed against the occipital end of the head, its presence may delay the descent of the occiput and thus produce extension at the brim. This abnormality usually causes a delay sufficient to induce exhaustion on the part of one or the other patient, and thus indicates operative interference; but if such an indication does not arise, the ultimate result in most cases is that the head slips by the prolapsed arm, after a greater or longer period of delay, and is thus eventually born by a natural labor.

Prognosis.—If the presentation is detected early, the prognosis is little different from that of normal labor, and even when detected after a moderately long second stage it is influenced by the treatment, and should never be grave.

Treatment.—An attempt should be made to push back the prolapsed hand with the fingers, and, if extension has occurred, to restore flexion by pressure upon the forehead with the hand. Should this effort fail, an operative delivery must be resorted to, the choice of operation depending upon the position of the head. If good flexion is present, the forceps should be applied, but care must be taken to introduce the blade between the hand and the head, and great care will be necessary to avoid fracture of the fingers, the hand, or the wrist. If the application fails to do injury, the prognosis of the operation is good, since the tractile force is applied to the head while the hand is still exposed to friction against the pelvis; the head thus always slips past the hand. When marked extension is present, if manual flexion fails or if the head is already much moulded toward the configuration of a brow, internal podalic version should be performed.

Presentation of a hand and a foot is decidedly more rare than the above; its prognosis and treatment are, however, similar.